Niveau(x) d'enseignement: 8
Centre d'intérêt: 23

Numéro EDUQ : 8170979

Segal, Mark David, 1941-.

The political economy of resource distribution in Quebec universities / Mark D. Segal. -- [Montréal] : Conference of Rectors and Principals of Quebec Universities, 1970.
xvi, 431, 63 p. ; 29 cm.

Texte en anglais avec résumé en français à la fin du v.
Bibliographie: p. 424-430.

Cote Dewey: 378.02'09714/S454p

Cote LC: LB/2342.2/.C38

Descripteur(s): *Analyse coûts-bénéfices *Analyse de coût *Salaire de l'enseignant *Financement *Analyse de systèmes *Qualité de l'éducation *Universitaire (Niveau)

Le document vise à apporter une certaine contribution à l'analyse des coûts et bénéfices de l'enseignement en milieu universitaire. Il comporte, de plus, un examen des coûts de l'enseignement dans deux départements, l'un de sciences et l'autre de sciences sociales, des universités McGill et de Montréal. Dans l'impossibilité d'obtenir des renseignements précis sur les autres éléments du coût total, le seul coût comptabilisé dans l'étude est le traitement des professeurs.

Le premier chapitre présente une discussion théorique de l'allocation des ressources dans les universités du Québec. Dans le chapitre II, en s'inspirant de la littérature dans le domaine de la psychologie de l'éducation, on tâche d'identifier les inputs et les outputs des processus d'éducation à la lumière de l'analyse des systèmes. Suit une présentation du schéma comptable utilisé subséquemment dans l'étude et une revue des diverses méthodes applicables à l'évaluation des inputs et de leur coût. Enfin, après avoir appliqué le modèle comptable aux quatre départements, l'étude illustre son utilité et sa flexibilité en l'appliquant à un cours de mathématiques et à un cours de psychologie qui reposent sur des pédagogies nouvelles. Le chapitre IV souligne l'utilité et les implications du schéma pour ce qui a trait aux prises de décisions intra-universitaires, inter-universitaires et extra-universitaires.

Type de document: r
Auteur de l'analyse: fr

BANQUE D'INFORMATION SUR
LA RECHERCHE QUEBECOISE EN EDUCATION

AUTORISATION DE REPRODUCTION

(S'il vous plaît, veuillez remplir un formulaire par document)

AUTEUR(S): Segal, Mark D. Conférence des recteurs et des principaux des universités du Québec

TITRE The political economy of resource distribution in Québec Universities

Disponibilité

o Ce document est présentement en vente ☐
chez l'éditeur:
numéro ISBN:

o Ce document n'est pas présentement en vente ☒

AUTORISATION

o J'accepte que ce document soit microfiché ou photocopié sans frais de ma part.
☒ oui (veuillez signer la formule ci-dessous)
☐ non

o J'autorise le Service de la recherche du ministère de l'Education et les organismes qui collaborent à la réalisation de la banque à reproduire le document ci-haut mentionné sur microfiche ou par moyen de photocopie pour distribution sur une base non lucrative sans exiger de droits d'auteur.

Signature date 14.09.81
Richard Pérusse
directeur général

14,04

E D U Q 8170979

THE CONFERENCE OF RECTORS AND PRINCIPALS
OF QUEBEC UNIVERSITIES

THE POLITICAL ECONOMY OF RESOURCE DISTRIBUTION IN QUEBEC UNIVERSITIES

MARK D. SEGA

THE CONFERENCE OF RECTORS AND PRINCIPALS
OF QUEBEC UNIVERSITIES

THE POLITICAL ECONOMY OF RESOURCE DISTRIBUTION IN QUEBEC UNIVERSITIES*

Mark D. Segal

November 1970

* Ainsi qu'un résumé en français.

FOREWORD

by Pierre-Paul Proulx,
Executive Director of
The Conference of Rectors
and Principals of Quebec
Universities

Ever since its establishment in January 1968, members of the secretariat of the Conference of Rectors and Principals of Quebec Universities have undertaken to prepare research papers on various topics.

I am particularly pleased to present to the reader this study by Mark Segal, for it comes at a time when universities in Quebec are about to witness the establishment of a data bank, the results of various cost studies and the undertaking of projects to develop more efficient and equitable planning and management methods.

In my estimation this study by Mark Segal will be of considerable use to whoever is concerned with the study of costs and benefits of university education. The author has addressed himself to a wide variety of topics, some in depth, and others quite superficially, as he himself points out, either because of the current state of knowledge in the area, or because of constraints on the time and/or resources at his disposal.

It is my belief and hope that any person who reads through this long study will understand the ambivalence of the author and that of his colleagues at the Secretariat of the Conference of Principals in attempting to contribute as meaningfully as possible to the development of cost analysis for use in universities on one hand, and in dwelling upon the limitations of cost analysis for rational decision making in universities on the other. The author restates in no uncertain words his discomfort with any decision or attempt to establish formula financing or interuniversity normalization on the basis of cost studies. Like his noble predecessor Alfred Marshall who stressed the importance of the "two blades to any pair of scissors", the author stresses the importance of benefit analysis in university financial decision making.

Mr. Segal has, in my view, successfully made the case for cost analysis and cost accounting by formal instructional unit and by activity within formal instructional units which may in some instances be a course, but not necessarily. The detail in concepts has made it possible for him to simulate the costs of novel teaching methods. I do hope that those responsible for defining data elements in the Quebec University data banks, and those responsible for financial and pedagogic research and decisions affecting Quebec universities will find this study, though partial in that it deals only with the instructional costs in four departments of two Quebec universities, of some value. I am quite certain that they will find subject matter to disagree with, as I have, but hope that in the end, they will consider the study a worthwhile contribution to knowledge in the area.

PREFACE

The Conference of Rectors and Principals of Quebec Universities established a secretariat in 1968 for several purposes, one of which is to develop an inter-institutional understanding of how universities work, from the pedagogic economic and administrative points of view.[1]

My task was to initiate some thinking about the problems and methods of conducting cost-benefit analysis in a way that yields valid comparisons from one university to another. It became immediately obvious that I required an inter-disciplinary approach, because costs are matters of economics, benefits—pedagogic and economic. Furthermore, any system-wide analytical tool that lends itself to prediction and planning has political implications of which academic politics are one part and statecraft the other. This essay therefore discusses three related issues: (1) the politics of decision making with analytic tools; (2) the issues of measuring and comparing academic benefits; and (3) problems and procedures of estimating a restricted area of cost: the human capital involved in teaching courses.

---

1. See the Conference of Rectors and Principals of Quebec Universities' First Annual Report entitled, "Interdependence and Harmonization" for further details on the objectives and activities of the Conference.

My political bias is a pluralistic one. I dislike imposition because I believe that it violates academic freedom; like most university persons, I believe that academic freedom is a necessary condition for the development of knowledge and for the survival of social criticism. Academic freedom does not mean—it cannot mean—that everyone does precisely what he pleases. In any system the behaviour of each element must co-ordinate with that of the other. Thus, I plead for consensus rather than imposition (either by the state or by single academic bodies within universities) in reaching whatever decisions the analytic tools help to develop. My political frame of reference is a slightly modified version of traditional welfare economics.

My approach to the question of academic benefits is largely a positive one. I make the case that the positive approach begins where the critical approach leaves off: once the critical issue of academic objectives is decided at any relevant level of decision making, I ask whether we can make general and inter-institutionally comparable statements about the most efficient and acceptable pedagogic methods that may be employed to reach these objectives.

I conclude that the present state of development of educational psychology does not permit this, therefore much in this domain remains to be done. I believe that it should be done because the university system is a major consumer of public resources. As such it has a public responsibility to be scientific and economic in its use of these resources, within the bounds of "academic decency". A corollary of this idea is that constant self-evaluation and self-criticism within the university sector falls within the bounds of academic decency. This notion may be somewhat revolutionary to many university persons, however, it is logically consistent with the scientific ethos that these same persons apply to their own areas of specialization.

My approach to the economic problems is both theoretical and empirical. The theoretical discussion is concerned with problems of evaluating and measuring the contribution of human capital to course instruction. The empirical work consists of building an accounting framework that integrates the elements of time, students and teachers into a synthetic whole, for the purposes of assessing course costs in a manner consistent with the proxy measures suggested by the theoretical discussion. I analyze the data collected for a sample of two departments in each of two universities and suggest some hypotheses of cost formation which may be developed by subsequent investigators both for change over time and between other samples at one point of time.

The conclusion comes back to the beginning, suggesting what the framework may be helpful to decide, and how it may be used.

Many people were very helpful in the development of this project. I owe a particular debt of gratitude to Professor J.C. Weldon of McGill University's economics department, who patiently read the text line by line and offered a multitude of important suggestions to improve the ideas and organization of the material. Mr. Nguyen Hung, a colleague at the Conference of Rectors and Principals of Quebec Universities' Secretariat prepared the computer programs and assisted me with mathematical statements under great pressure of work. His contribution is an indispensable element of computable analysis. Dr. Richard W. Malott of Western Michigan University gave freely of his time and personal hospitality to permit an analysis of his unusual system of contingency management in an introductory psychology course for one thousand students. He also read Chapter Two and offered valuable suggestions for its improvement. Mr. Guy Gelineau, a colleague at the Conference of Rectors and Principals of Quebec Universities' Secretariat also read Chapter Two and offered valuable advice for its improvement. The assistance of these two psychologists was particularly useful to a non-specialist in that field. Mr. Donald Kingsbury of the Mathematics Department, McGill University, willingly assisted me in the development of a model of his proposed "Math Learning Centre" which incorporates many structural features uncommon to traditional course structures. The hard-pressed administrative assistants of the departments analyzed in the empirical section were very patient and helpful in my efforts to secure the necessary data for the accounts. Data collection was not an inconsiderable task, and our discussions were useful in the evolution of the accounting framework to its present form.

My other colleagues in the Secretariat of the

Conference of Rectors and Principals of Quebec Universities read drafts of the material and their comments were also helpful.[2] In conclusion I express gratitude for the administrative support that I received. Mr. Pierre-Paul Proulx, Executive Director of the Conference, gave me a free hand to conduct this work and waited with patience and understanding as it developed into a longer term project than we anticipated. Mrs. Tanya Rosenberg typed, re-typed, and proof-read with perseverance, good humour and efficiency. The administrations of McGill University and the Université de Montréal were helpful in facilitating access to information. The Conference of Rectors and Principals, through the Executive Director, financed the project.

As usual, all mistakes and shortcomings are my responsibility.

Mark D. Segal

Montreal
August 1970

---

[2] M. Pierre-Paul Proulx, Mr. Jacques Bordeleau, Mr. André-Pierre Contandriopoulos, Miss Susan Martin, and Mr. Jean-Marie Dubois.

The author welcomes comments and correspondence. He may be reached at the Economic Research Bureau, University of Tanzania, P.O. Box 35096, Dar Es Salaam, Tanzania. Air mail recommended—25 cents per half ounce.

INDEX

Page

FORKWORD.. iii

PREFACE.. vi

ACKNOWLEDGEMENT.................................. ii

INTRODUCTION..................................... 1

CHAPTER I-Resource Distribution in Quebec Universities.............................. 9

CHAPTER II-Systems Analysis of Educational Achievement............................. 35

CHAPTER III-The Accounting Framework............. 113

- I. Budgeting Techniques................. 113
- II. Description of the Framework........ 120
- III. Cost Analysis....................... 171
- IV. Program Planning.................... 269
  - 1. Mr. Kingsbury's Proposed Math Learning Centre.................. 269
  - 2. Economics of Contingency Management in an Introductory Psychology Course for 1000 Students......................... 310

APPENDIX I- Math Learning Centre (D. Kingsbury)... 390

APPENDIX II- Solving for Cost Constraints......... 393

APPENDIX III- Extended Time Horizon............... 405

APPENDIX IV- Data................................. 412

APPENDIX V- Suggested Research.................... 423

BIBLIOGRAPHY...................................... 424

FRENCH RESUME-RESUME EN FRANCAIS.................. 431

LIST OF FIGURES AND TABLES

Page

FIGURE I—Sample-Course Accounting Framework........ 122a (see inside cover)

FIGURE II.. 127

TABLE I.. 130

FIGURE III—Illustration of Index Number Comparisons 197

TABLE II-1—McGill Science Values of 12 Variables by FIU Level............................ 199

TABLE II-2—Montreal Science Values of 12 Variables by FIU Level............................ 200

TABLE II-3—McGill Social Science Values of 12 Variables by FIU Level.................. 201

TABLE II-4—Montreal Social Science Values of 12 Variables by FIU Level.................. 202

TABLE III-1—McGill Science Intra-Departmental Indices 203

TABLE III-2—Montreal Science Intra-Departmental Indices................................ 204

TABLE III-3—McGill Social Science Intra-Departmental Indices................................ 205

TABLE III-4—Montreal Social Science Intra-Departmental Indices................... 206

TABLE IV-1—McGill Science Inter-Departmental Index Bases.................................. 207

TABLE IV-2—Montreal Science Inter-Departmental Index Bases............................ 208

TABLE IV-3—McGill Social Science Inter-Departmental Index Bases............................ 209

TABLE IV-4—Montreal Social Science Inter-Departmental Index Bases............................ 210

TABLE T-1—Comparisons of "A"........................ 216

LIST OF FIGURES AND TABLES (con't)

Page

TABLE T-2—Comparison of "CU" and Comparison of "Pe".. 220

TABLE T-2(a)—Mean of Means by University............. 224

TABLE T-3—Comparisons of "C" and Comparisons of "e".. 227

TABLE T-3(a)—Mean of Means by Discipline............. 229

TABLE T-3(b)—Mean of Means by University............. 231

TABLE T-4—Comparisons of "Pt" (for professors) and
Comparisons of "SA" (for professors) and
Comparisons of "Ta" (for professors) and
Comparisons of "x" (for professors) and
Comparisons of "CH" (for professors)....... 234

TABLE T-4(a)—Professors' Workload Distribution by
Department, Level and Activity (in hours).. 236

TABLE T-4(b)—Professors' Profiles by Department...... 237

TABLE T-4(c)--"AUTRES" Comparison of "Ta" and
"AUTRES" Comparison of "SA"................ 238

TABLE T-4(d)—Wage Bill of "AUTRES" by Level and
Department................................. 239

TABLE T-4(e)—Comparison of Professorial and "AUTRES"
Wage Bill.................................. 239

TABLE T-4(f)—Hourly Price and Use of "AUTRES"........ 245

TABLE T-4(g)—Mean of Means by Discipline (professors). 247

TABLE T-4(h)—Mean of Means by Discipline (AUTRES).... 250

TABLE T-4(i)—Mean of Changes by Discipline
(professors)................................ 251

TABLE T-4(j)—Mean of Means Changes by University
(Professors)................................ 254

TABLE T-5—Comparisons of "g" (professors) and
Comparisons of "g" (AUTRES)................ 258

LIST OF FIGURES AND TABLES (con't)

Page

TABLE T-5(a)—Comparisons of "z" (professors)......... 260

TABLE T-5(b)—Comparisons of "z" (AUTRES)............. 261

TABLE T-5(c)—Mean of Means by Discipline............. 263

TABLE T-5(d)—Mean of Changes by Discipline (Professors)........................... 264

TABLE V—Comparative Accounts—Math Learning Centre and Lecture System.......................... 274

FIGURE IV—Replication Structure-Student Activity..... 329

FIGURE V—Replication Structure-Staff Input........... 331

TABLE VI—Summary of Activities....................... 347

TABLE VII—Distribution of Workloads by Rank.......... 353

TABLE VIII—Accounts-The Psychology 150 System........ 360

FIGURE VI—Cost Constraints Table..................... 403

INTRODUCTION

University administrations in the Province of Quebec feel the need for increasingly sophisticated analyses of their resource utilization. Economic expansion in the Province of Quebec, the growth of the university sector, and the expanding financial commitments that the provincial government assumes on the behalf of the universities all contributed to the development of this need.

The university sector grew over the years with no system-wide comprehensive planning. Furthermore, individual universities generally make little use of planning tools such as systems analysis, cost-benefit analysis and program budgeting techniques. The tools are relatively recent and their applicability to the university sector is a matter under current study in numerous institutions around the world.[1] Confidence in the techniques may develop depending upon whether or not the technicians succeed in demonstrating the extent to which they are operational, reliable and politically acceptable.

---

[1] See O.E.C.D. Bibliography, "Systems Analysis for Educational Planning". Paris,1969.

Society finances the universities in many ways. Funds accrue from public grants, private donations, and student fees. They are expended on teaching, research and other public services. We describe the factors which determine the level of support to the university sector as demand and supply factors. On the demand side, economists sometimes distinguish between "consumption" factors and "investment" factors.[2] "Consumption" usually refers to a demand for education that is not explicitly related to the development of human capital for the purpose of generating a future stream of private and social economic benefits, while education which is directed at this purpose is "investment". On the supply side, we refer to the resource requirements, and their costs, for producing educational output.

---

[2] We believe that the distinction is an artificial one, for the following reason: it is difficult to distinguish factors in the education of an individual that are conducive to future economic benefits from those which are not.

Although it is difficult to actually separate consumption from investment in education, the distinction is an important one. It matters to the level and kind of education made available.

Our central concern in this essay is to suggest ways of defining educational output and its cost of production. We do not discuss demand, nor do we hypothesize how supply and demand interact to yield a level of financial support for the university sector. While university persons and other demanders may all contribute to the development of demand functions for university services, we suggest that the university community may be the best one to make statements about efficient and acceptable supply functions, because few non-university people may have the necessary expertise or involvement. We believe that for the university sector to have a reasoned opinion on the matter of entitlement to funds, it should know the economics of how it produces what it does produce, as well as how it may produce in the future.

The major problems we encounter are the highly differentiated nature of university educational output and its corresponding inputs, as well as the difficulties of measuring inputs and outputs which have important qualitative characteristics that are difficult to quantify in any generally satisfactory way.

Our present position is the following: the state of the art makes it difficult to accurately generalize about the pedagogic benefits (output) of one educational technique and program structure over another; yet with the aid of some rather restrictive hypotheses, we can make indicative statements about relative teaching costs that decision makers may find useful in their efforts both to assess existing cost structures, as well as to plan future program offerings with systematic costing techniques and cost estimates in mind.

The essay contains four chapters. In Chapter One we situate the production function in a context of social and university welfare. We discuss the notion that resource-using decisions involve the welfare of the community, as well as that of students and teachers, because any decision should take account of their preferences. We suggest that the introduction of new decision-making tools has welfare implications because it may change preferences and decision procedures. We establish the general nature of the case without specifying particular problems and solutions. We suggest that these may depend very much on their precise institutional context and we recommend subsequent investigation into the area of decision techniques and their affect on welfare in the university community.

We begin Chapter Two with a discussion on the nature and requirements of systems analysis. It is an examination of how information about inputs, process and outputs should be defined and organized to meet these requirements. We then present a précis of a review of the literature on educational psychology to determine how we may make systematic statements about the inputs, processes and outputs of education. We emerge from the discussion with the conclusion that we can make systematic statements about some quantitative inputs and outputs, but these do not throw much light on the qualitative merits of the results. We suggest that this situation may be met partly by the use of more controlled learning experiences, and partly by reliance on staff and student intuitions until better methods are developed. Readers who are more interested in the financial aspects of the analysis may refer directly from Chapter I to Chapter III.

In Chapter Three we develop an accounting framework which is a systematic approach to estimating actual or planned production relations and costs of production of university programs as well as their component activities. The Chapter contains four parts. Because we intend that the accounting framework should be used to assess the cost of programs, in Part One we introduce the main principles of program budgeting. We suggest a framework of student accounting according to the activity composition of their programs.

In Part Two we discuss the methodological problems of estimating input values and their costs, and we suggest simplifying hypotheses that allow us to construct approximate cost accounts of university teaching activities which enter into these programs. The accounts are approximate in the sense that they isolate measurable teaching activity which incurs costs to the university. Furthermore, they are limited to consideration of human resources inputs that perform the instructional activities of teaching, leading discussion groups, supervising laboratories and correcting students' work. We also account for specific administrative costs, or those which are not shared with any other activity and which constitute an integral part of the teaching of that activity.

In Part Three we use the accounting framework to make comparative cost statements about the teaching programs of a comparable science department, and a comparable social science department in each of two universities in the province of Quebec: McGill and Université de Montréal.

In Part Four we test the adaptability of the accounting framework to estimate the costs of "new" teaching systems. We intend this section to illustrate the flexibility of the framework, as well as its utility for future planning.

The accounting framework is very disaggregative. It calls for detailed information about the description, timing, staffing and participation of teaching activity. While the approach may have the inconvenience of imposing substantial data-gathering requirements, we do not believe that this is a significant hindrance where computers are available. It has the advantages of aiding multi-level planning within the institution, as well as permitting detailed analysis of the cost-sensitivity and quantitative importance of the many elements that enter into the activities.

In Chapter Four we discuss the policy value of the accounting system. We discuss where it may be used to advantage, and the kinds of questions that it may be called upon to inform. We conclude that at its present state of development it could be used with caution for intra- and inter-institutional program-budget planning. We suggest that several areas of research are indicated to improve the state of the art. They are professorial activity analysis, the substitutability, complementarity and costing of audio-visual techniques, as well as the evaluation of student time in different learning systems. Of course, no planning system will be complete without the estimation of utilization rates and costs of support services such as administration, library, non-instructional staff, buildings and grounds, student services and others. Each one of these functions requires concentrated study in the future.

THE POLITICAL ECONOMY OF RESOURCE DISTRIBUTION IN QUEBEC UNIVERSITIES

CHAPTER I

When universities were smaller and financed privately to a much larger extent than now maintains, little public attention focused on two substantial issues which are of present concern in this paper.

(i) the level of university finance; that is the dollar value of community resources to be placed at the disposition of universities relative to other pursuits, and,

(ii) the distribution of resources between the universities.

(i) Level of Finance:

This issue is a social welfare problem the resolution of which depends on our ability to determine a social welfare function. Theoretically such a function would represent an ongoing equilibrium of equal social marginal utility derived from the last dollar spent on universities relative to other areas of expenditure. The social welfare function is more than an economic one. It also contains cultural factors.

With regard to economic utility, several allocative problems complicate the situation of utility criteria and their measurement. We[1] refer to these problems as (i) inter-generational conflict of interest, (ii) contemporary class conflict of interest, (iii) the absence of market mediation, and (iv) the definition of the goods that confer utility.

The problem of inter-generational conflict of interest is one of defining the value that the present generation attaches to the consumption of future generations. The more the present generation deprives itself of consumption, and the more it invests its resources in the education of future generations, the more conducive this behaviour may be to the economic well-being of the future generations. The economic measure of this well-being is generally a stream of future income discounted to its present value. The major imponderable factor in this measurement is that of the appropriate rate of discount to apply. The value of this number expresses society's taste with respect to the comparative value of present and future consumption. We do not know how to choose it.

---

[1] While the introduction is in first person singular (being a more personal statement) I use the traditional first person plural in the main text.

The problem of the contemporary class conflict of interest is that of "winners and losers" from any redistribution of income. The nature of the redistribution is that taxpayers finance a considerable proportion of university expenditures, and the benefits of this expenditure are not necessarily distributed in a way that is proportionate to the distribution of the costs. The university student gains directly from his education because his diplomas qualify him for relatively high levels of personal income. To the extent that his activities have the external effect of increasing national income and the earnings of non-university educated people, those who have not been to university benefit as well. The problem is that of determining the appropriate distribution of shares between the educated and the non-educated classes in the composition of the social economic welfare function.

The absence of market mediation complicates the resolution of the generational and the class conflicts. If the services of universities were bought and sold on a free market, if there were no externalities in consumption or production, the free play of supply and demand would determine a market price which the consumer would pay to the institution for the bundle of goods he buys. No such free market for university services exists because there are external consumption effects, and the public sector constitutes an external influence on the rate of production. Under these circumstances, the pricing system cannot achieve perfect allocation and it therefore becomes necessary to introduce substitute allocative criteria that involve some form of agreed price and distribution. It is important, therefore, for university persons to become quite exact about notions of supply price of university goods and services.

The definition of goods is no small problem in the university sector. The product is very individual and hard to measure. It is also difficult to generalize about its method of production because the variety of methods is as vast as that of the different combinations of input factors to the process. We consider this problem to be a fundamental one and analyze its nature in the following chapter. The purpose of our discussion on the nature of processes and output is to illustrate that in education as in any other process, it is difficult to make economic statements unless we can define production functions. We analyze some of the problems, their implications, and suggest how we may begin to overcome them.

The cultural factors that enter into the social welfare function are considerable. Education represents the kind, level and distribution of knowledge in our society. Perhaps for this reason more than any other, university education is not only a private good, but also a public good. Obviously, the character of the society is partly determined by its use and production of knowledge, and this is a much larger matter to assess than rates or return calculations are appropriate to measure.

The formal theory of welfare economics[2] offers no comfort with regard to determination of the social welfare function. This is not surprising as it can hardly be expected that a theory characterizing society as bound to respect the ordering of every individual within it, will be able to determine a single socially acceptable welfare function.

---

[2] Mishan, E.J., "A Survey of Welfare Economics", in Surveys of Economic Theory, Vol. 1, American Economic Association and Royal of Economic Society, London, 1965.

Yet, the social welfare function should be the starting point of the investigation. The economist working in the context of publicly financed universities is faced with the problem of rational resource allocation in a democratic context. If he cannot make positive statements about individual ordering of priorities, and the relationship between individual and social orderings, then he may hypothesize various individual orderings as well as the forms that the social welfare function may assume, and demonstrate the implications of one form over another. In this way, the economist may assist not only in the discussion of generally acceptable objectives for the system, but also in ways to achieve them.

On the question of fact, it is by no means obvious how the universities and other elements of society view the priorities of higher education. On the question of approach, the technical investigation of the economist is not necessarily neutral

With respect to the question of fact, since we have no explicit rules to pass from individual orderings to a social ordering, the political system allocates public expenditures between different endeavours by obscure criteria. The absence of an agreed and explicit social welfare function suggests that the distribution of public expenditures is ultimately imposed by whatever institutions to which the society delegates this function.

The distributive criteria are obscure

because we have little reliable knowledge about the ways in which various forces on the public purse determine the relative weighting of need in the system. Given the facts of imposition and obscurity, the existing university sector[3] is faced with two possibilities, perhaps not mutually exclusive:

(i) To define its view of a social welfare function out of which it deduces its own policies and requirements. This is to say that the university sector must be "critical", meaning that it aims to behave according to its vision of society.

(ii) To behave as an intermediary of an external situation and state the material conditions which, in its view, yield an optimal production process of whatever is demanded of it at any point in time. We define this mode as the "positive" approach.[4]

---

3. It is very important to note that for purposes of this study whenever we talk of university sector or university system or university we use these terms as convenient abbreviations for the sum of activities carried out by students and teachers. We do not assume that the whole is simply the sum of the parts or that the university sector, or even a single university behaves as a monolith. This would be inconsistent with reality and with the normal understanding of the character of intellectual pursuit. Thus, we do not assume away the problem of welfare consistency between the individuals within the units comprising the system. This concern is central to our argument.

4. Our distinction between "positive" and "critical" modes is borrowed from the vocabulary of philosophy. Marcuse (One Dimensional Man, Eros and Civilization, et al.) views critical analysis as a mode which considers alternative values to the status quo, while positive analysis accepts the environment and analyses it in great detail, to render it an internal rationality that may have little to do with the greater rationality of the thing itself.

It is possible that the size of the university sector may have some effect on the extent to which it can be critical. Thus, the mix between positive and critical behaviour could vary as the system grows. Size is not the only variable; other strategic factors such as intellectual influence and its position as a main supplier of human capital may be at least as important. Critical, positive or a mixture of both, the university is an institution in society that, like many others, has welfare to maximize as well.

With respect to the non-neutrality of technical investigation, we demonstrate that the normative implications of cost analysis and its applications must be incorporated in the elaboration of the analysis itself if the whole exercise is to make any sense in terms of whatever objectives the academic community would be prepared to entertain. Our concern is inspired by the desire to be explicit and honest about the inevitable connection between ethics and economics. In this respect, we quote the following explanation of the problem from Boulding:

> "The myth that science is simply discovering knowledge about an objectively unchangeable world may have had some validity in the early stages of science, but as the science develops this myth becomes less and less

valid. The learning process of science is now running into two serious difficulties. The first might be called the generalized Heisenberg principle. When we are trying to obtain knowledge about a system by changing its inputs and outputs of information, these inputs and outputs will change the system itself, and under some circumstances may change it radically. My favourite illustration of the Heisenberg principle is that of a man who inquires through the door of a bedroom where his friend is sick, "How are you?", whereupon his friend replies "Fine.", and the effort kills him. In the social sciences of course the generalized Heisenberg principle predominates because knowledge of the social sciences is an essential part of the social system itself, hence objectivity in the sense of investigating a world which is unchanged by the investigation of it is an absurdity.

"The second difficulty is that as science develops it no longer merely investigates the world; it creates the world which it is investigating. ...

"We cannot escape the proposition that as science moves from pure knowledge toward control, that is, toward creating what it knows, what it creates becomes a problem of ethical choice, and will depend upon the common values of the societies in which the scientific sub-culture is embedded, as well as of the scientific sub-culture. ...

"Under these circumstances, the concept of a value free science is absurd, for the whole future of science may well rest on our ability to resolve the ethical conflicts which the growth of knowledge is now creating. Science could create an ethical dynamic which would bring it to an end." [5]

It would be unfortunate if the universities were to develop scientific allocative procedures, and they did not have the will and the freedom to insure that the procedures only change them in ways that they find acceptable to change. Unless the universities have some critical powers, they may not be able to control the effects of their own creations.

---

[5] Boulding, Kenneth, "Economics as a Moral Science". A.E.R., March, 1969.

It is unfortunately beyond the confines of this essay to theorize on the conditions that favour the emergence of the critical mode. However, we emphasize that the analytic tools we develop could be in the service of both critical and positive systems.

Whether it is to be a set of critical or positive institutions, the university system will have to know how the relevant cost variables interact to yield any necessary level of consumption of funds. It needs to know the nature of its production functions to make the case for the level of expenditure requisite to optimize its input/output relationships within both an imposed and autonomous set of priorities.

As much as the universities may fulfill their responsibilities to optimize social welfare, as autonomous institutions operating in the society, they also have individual and perhaps collective welfare criteria which they would like to optimize. Unless they are financed in a way and at a level which permits them to do this, there will be inconsistency between social and university welfare. The absence of rules to pass from individual to a social ordering suggests that inconsistencies may have to be eliminated by imposition.

There are two aspects which loom large in the welfare criteria of the university system: one is a matter of "final product" and the other of "process". As difficult as it may be to establish general linkages between the two, we must countenance the intuition that process affects final output in qualitative and quantitative ways.

When we talk of final output, we mean the kinds and quantity-per-kind of specific talent the system produces. With regard to process, there are as many processes as there are different learning systems. The welfare of the university is involved both in what it produces and how it produces. To situate the fulfillment or non-fulfillment of university welfare criteria, we should like to have categories of welfare description that lend themselves to measurement, and that are sufficiently precise to distinguish between the different "processes" which constitute welfare.

We describe the process in terms of its inputs, and the ways in which these inputs combine to yield output. Students, professors, support staff, and the material conditions in which they work are inputs. Within the confines of our study, a modified student is the output.

It is the subject matter of Chapter Two to establish ways of measuring inputs and outputs, and of Chapter Three to find ways of defining and describing the structural features of the process.

If it is true that process and final output are linked [6], and if it is true that the welfare of the university system is defined by both, and the welfare of other sectors of society principally by the latter, then consistency between university welfare (both aspects) and social welfare is necessary.

---

[6] This is implied in many student discussions of the university process where it is often asserted that the mass lecture system imposes passive learning modes and hence creates cogs to fit into an industrial machine. Serious centres of educational research around the continent are concerned to design programs and teaching methods which do not encounter the alienation that is an admitted and undesirable phenomenon on many university campuses. We will attempt to simulate one such design developed in McGill University to see how much it could cost compared to actual designs analyzed in Chapter III. We also account a design which Dr. Richard Mallot and his colleagues at Western Michigan University developed to teach behavioural psychology.

How is it achieved? There are three possibilities; they emerge from our previous discussion of the implications of the Arrow argument on imposition as it relates to universities.

(1) The society imposes its will on the universities.

(2) The universities impose their collective will on the society.

(3) The societies and the universities mediate and compromise.

The first approach denies the existence of the free university. Since freedom is an important factor in the welfare of the universities (as any number of official university pronouncements would testify) and since our political and social structures theoretically recognize the legitimacy of university freedom, we consider this approach to be an improbable one.

The second approach assumes that the university sector is critical and that it has powers of imposition.

It defines welfare not only in terms of the kinds of educated people it produces, but also how it does it, and imposes this welfare criteria on society by creating the sort of scarcities and abundances which could determine the direction of social activity [7] on four conditions:

(1) it monopolizes the supply of higher education within its own geographic jurisdiction,

(2) there is no inter-jurisdictional factor mobility,

(3) it is financially independent, or

(4) other factors such as prestige give it powers to determine the direction of social activity.

While we do not engage in this discussion here, we suggest that it is essential to study the nature and existence of these conditions to determine when and how the critical university can exist. We may then discover the context in which decisions about the nature of the production function are made.

---

[7] In the New Industrial State, J.K. Galbraith sees the main impetus of non-violent improvement in the quality of life as coming from the universities. These are strategic in the formation of thought processes of future elites. We offer the suggestion that present interests understand this all too well and are understandably concerned about the recent instability on campuses all over the world.

This issue is decisive for welfare issues because it has important implications for institutional freedom and for the politics of choice within the university community itself—choices which determine the relations of production and hence an important aspect of the welfare of the university.

If the conclusion of a study of this problem indicates that the university system must be something less than critical under conceivable conditions here in the foreseeable future, it will be necessary to explore how positive analysis will affect a compromised autonomy. We must approach the political economy of systems analysis in the university sphere, if we accept the Heisenberg principle and are concerned about welfare.

The conclusion of this discussion is that for purposes of determining an appropriate level of university finance, it is not only important that the universities be able to state their case, but also make it prevail in a way that is consistent with social welfare. In this study we concentrate on ways to state the case.

(ii) The distribution of resources is a welfare problem which usually arises in any university system characterized by the existence of more than one institution, or more than one "campus" of a single institution. We refer to an institution or a campus of a regional institution as a "unit" in the following discussion.

The issue to be decided is "who gets how much". If we could view the matter from the level of the total system we could advance the judgement that the system should seek to realise its desired instructional output at least cost [8] per student. Output is defined as kinds of talent. When we speak of least cost, for the problem to have any economic importance we assume that some different processes can turn out largely the same product, that there are different processes between which the university system is indifferent in utility terms (it is

---

8. When we speak of cost here we include only some costs, i.e., the cost of production accounted by the institution for the activity it undertakes as an institution. We have chosen not to complicate the discussion with external costs (e.g. the cost of student time spent in the university) because this would open a large area which we must leave to subsequent investigation.

prepared to exchange one process for another and if necessary can be induced to make such changes because cost influences the utility of any process) and the objective is to choose the least costly process which does not impair the welfare of the institution. We must also assume that there is some freedom of choice.

If there were no other complicating factors, the unit providing the particular output required at least cost would attract the funds and the distribution problem would be laid to rest on the simple hypothesis that a total can only reach a minimum when each of its constituent amounts is at a minimum.

Unfortunately, there are other complicating factors. The "system" is not a monolith with a uniform idea of what constitutes optimal welfare either in terms of output or process, for any aspect of its activities. Each unit may have its own welfare criteria that is just as valid as that of any other unit in the traditional framework.

For example, two units wish to produce chemists because society needs them or because they believe that chemists are "a good thing". There are chemists and there are chemists. And there are programs and programs. Not all programs would turn out roughly the same chemist (even if we could assume homogenuous human input at the start of the process), they do not all cost the same, and even among those that do turn out roughly the same product, some processes may be cheaper per student than others. Process and output are complementary aspects of unit welfare. Because a process in unit A is cheaper than that of unit B, unit B may have reasons for preferring its own process and in democracy, theoretically, we cannot impose a pattern on B (either directly, or indirectly by juggling allocations) simply to save money. Interpersonal utility patterns are inconsistent with formal allocative criteria.

If we define utility maximization of the system as its main objective, and if we adhere to the Paretian condition that total welfare is only increased if we can make one unit better off without making any other worse off [9], this militates against homogenizing units at the lowest level of cost. It also raises the relevance of cost analysis to criteria of resource distribution. With regard to the Paretian optimum, Boulding has this to say:

---

[9] Mishan, op. cit., page 163.

> "Many, if not most, economists accept the Paretian optimum as almost self-evident. Nevertheless, it rests on an extremely shaky foundation of ethical propositions. The more one examines it, for instance, the more clear it becomes that economists must be extraordinarily nice people even to have thought of such a thing, for it implies that there is no malevolence anywhere in the system. It implies, likewise, that there is no benevolence, the niceness of economists not quite extending as far as good will. It assumes selfishness, that is, the independence of individual preference functions, such that it makes no difference to me whether I perceive you as either better or worse off. Anything less descriptive of the human condition could hardly be imagined. The plain fact is that our lives are dominated by precisely this interdependence of utility functions which the Paretian optimum denies....
>
> "The almost complete neglect by economists of the concepts of malevolence and benevolence cannot be explained by their inability to handle these concepts with their usual tools. There are no mathematical or conceptual difficulties involved in inter-relating utility functions, provided that we note that it is the perceptions that matter. The familiar tools of our trade, the indifference map, the Edgeworth Box, and so on, can easily be expanded to include benevolence or malevolence, and indeed without this expansion many phenomena such as one way transfers cannot be explained." [10]

Boulding thinks it possible to create common values to integrate the system and economists have had much influence in this activity.[11] Thus, the problem of welfare comparison would not be insuperable, if the individual institutions were prepared to build a benevolence factor into their welfare functions that would facilitate financial compromises between them.

---

[10] Boulding, op. cit., page 5.

[11] Boulding, op. cit., page 7.

Even if there were no problems in interpersonal or inter-unitary utility comparisons, there still exists the problem of the non-measurability of some of the welfare criteria involved. The difficulty with the non-financial utilities of university process and outputs is that there is no objective way of translating them into dollar benefits. With regard to process, for example, it would be absurd to ask a university professor and students how much income they would be prepared to sacrifice to have a class of ten bright students as opposed to an "auditoire" of 600 (ranging from brilliant to impossible) because the factors which determine their need for income and the factors which determine their value to the institution probably have little to do with their tastes regarding pedagogic process. The question would be rather senseless, yet the utility problem may still be very real if financial constraints impose processes on them which they find disagreeable, or if they perceive that they are not really evolving the kind of product they would like to be evolving.

For both process and output, cost/benefit analysis would be very much simpler, and consensus would be very much easier to achieve were the benefits clearly measurable. The fact that they are not makes cost/benefit analysis necessarily subjective to a considerable extent. It will have to be done on the basis of some process of revealed preference. This situation makes it all the more necessary when articulating cost-accounting frameworks, not to ignore the very real issue of which and whose preferences will be revealed to whom, how and by who will allocative decisions be made. The design and use of an accounting framework which identifies outputs and the programs and inputs which produce them will have implications for all of these questions if only because relationships become identified in a way they have not been identified before. These implications must be articulated unless we were to dismiss the Heisenberg Principle as irrelevant to this sphere. We could only do this if investigation were to justify such a conclusion.

Hansen[12] is also concerned that the qualitative aspects of benefits be accounted for and that the implications of program-budgeting for university freedom be considered, granted the necessity of rationalizing budget-making procedures toward program planning and measurement of costs and benefits.

The problem is that a good deal of decision making in the university sphere is based on intuitive criteria that are difficult to articulate and verify. It may be that the consideration of alternatives has not always been accompanied by the kinds of information about costs that would inform the discussion and help decision makers to make more rational decisions. Costs can be measured as long as one is prepared to make some uncomfortable, but at least explicit, assumptions about how they are formed. Careful interpretation of admittedly imperfect cost data could encourage the units to develop a more informed and

---

12. Hansen, B.L., "Brief of the Structure and Operation of the Operating Grants Formula for the Provincially Assisted Universities of Ontario 1967-68 through 1969-70". Committee of Presidents of Ontario Universities. May 1969. Mimeo.

critical appreciation of their tastes. Price informs discussion. For example, it will help the decision makers to choose the cheaper of the alternatives between which the relevant parties are indifferent. It will also provide data to discuss the costs at which relevant parties are prepared to trade off one set of preferences for another. The pricing aspect will decide nothing of itself, but it may encourage the kinds of system wide rationalization that respect the rules of welfare maximization in the liberal frame of reference.

Summary:

We have argued that the welfare of the university system is not only derivative from the welfare of the society which it serves, but also has an autonomous existence which includes both output and process. Output and process are linked. Consistency between university and social welfare is necessary and may be obtained in several ways, some of which may compromise the autonomy and hence the welfare of the university system. It is necessary to explore the conditions conducive to the determination of social welfare from the university perspective and how cost analysis affects these conditions. The costing of process is essential to make the case for the level of expenditure that respects university welfare criteria with regard to process, as well as university and social criteria with regard to output. Costing on a basis that is inter-institutionally comparable also informs discussion about inter-unitary resource distribution and rationalization that respects the welfare criteria of the individual units. The absence of clear-cut benefit estimates renders it especially dangerous to ignore how systems analysis affects the politics of choice within and for all of the systems.

The preceeding discussion impels us to research three problems:

(1) Can the critical university exist?
(2) What are the linkages between process and output?
(3) How are costs, process and output defined and analyzed?

We do not examine the first question.

The second question involves an examination of the literature on educational psychology to see whether it can inform us on the relationship between pedagogic process and final product. We note that in this area the waters are murky even for the specialists. We may, however, advance some propositions that will be useful background for the simulation of alternative program designs which we do in the fourth part of Chapter III.

The third question involves the definition of concepts, or the main variables thought to influence the value of several measures of cost, the organization of these variables into a coherent system or accounting framework, and the application of this system to a sample of the real world in order to test its operationality and explanatory value. We shall also discuss the policy aspects of using this accounting framework for decision-making, as the above comments indicate it our responsibility to do.

We discuss the methodological problems proper to each area of investigation in the relevant chapters.

"To many it will always seem better to have measurable progress toward the wrong goals than unmeasurable and hence uncertain progress toward the right ones."

J.K. Galbraith
The New Industrial State

CHAPTER II

SYSTEMS ANALYSIS OF EDUCATIONAL ACHIEVEMENT *

I. Introductory statement

II. System defined

III. Identification of variables in the educational process

IV. Learning processes.

I. Introductory Statement:

In this chapter we discuss the possibilities and limitations of systematically describing the educational process. In Part Two we introduce the general requirements and characteristics of systems analysis.

In Part Three we conceptualize how the educational process may be systematically described. We visualize the system as one where inputs such as time, students, professors and environmental factors combine and interact in a process that yields an output of education. We seek to determine the properties by which inputs, process and outputs may be identified, and to determine in what ways we may state production functions of education.

---

* Readers who are more interested in the financal aspects of the analysis may refer directly from Chapter I to Chapter III.

The premise of this discussion may appear to be that learning is the only accomplishment which university experience confers on students. We are aware of the idea that university experience may affect the student's whole personality, and not only those aspects of it that have to do with learning and approaches to learning. Learning information and acquiring the ability to transfer intellectual skills are isolated aspects of personality development. We do not minimize either the relevance to learning or the importance of cultural, social and emotional personality characteristics which the university experience affects; however, we presume that the main purpose of university attendance is that of developing intellectual skills. They are our principal concern.

We organize the discussion of input classification issues as follows:

(a) Time:

i. Systematic statements about time assume regular and fixed activity sequences. This limitation may not accurately reflect reality.

ii. Various aspects of educational activities do not lend themselves easily to chronometric treatment.

iii. An amount of time devoted to an activity may be quite uninformative about the quality of the activity or the result.

(b) Teachers:

i. We limit ourselves to rank and salary classification of teachers at this stage of our analysis.

ii. We do not have a generally valid system of teacher ratings by which to describe and measure teacher quality.

(c) Students:

i. The description of the student both as an input and an output in the process is strategic to the utility of cost-benefit analysis in higher education.

ii. Learning is influenced by a multitude of variables. It is therefore difficult to isolate the effect of university experience on the development of intellectual skills, or to systematically measure it.

iii. We discuss the importance of four groups of student variables that affect or may be affects by learning: they are physical, intellectual, emotional and cultural variables.

In Part Four we discuss the learning process. We suggest a general definition of learning, and review the literature relevant to the analysis of what constitutes learning. We discover that a theoretical understanding of the learning process does not produce a "best" kind of instructional procedure, and that some procedures are more appropriate than others, depending upon objectives and the state of a large number of variables. It is therefore difficult to establish production functions that are generally efficient. We conclude that for the time being we can be most systematic only about the form the production process assumes. Institutionalized research in the field of educational psychology should gradually increase our ability to make better statements about the efficiency of educational processes.

We raise three related political questions in this introductory statement which we do not explore in the remainder of the chapter. The first of these is that of choice of objectives. The choice of educational objectives could be a contributing factor to the choice of educational techniques, because some techniques may be more suited to certain objectives than others. Systems analysis cannot answer the political question of who should decide the objectives. Once the objectives are decided, it may help to accomplish them.

The second political question is whether or not systems analysis will create tendencies to osmosis and homogenization of education. We do not believe that such an outcome is inherent in a systematic approach. Much depends upon how it is used. As long as the users of systems remain open and conscious of the need for adaptation and change to more useful and relevant methods, systems analysis should not be a factor of osmosis. In fact, the consideration of alternatives is fundamental to its approach. It need not be a factor of homogenization if the philosophical premises of psychological research in education are those that value the needs, aspirations and potential of the individual.

The third political question is that of demarcation of concern. If we limit our concern to students presently within the university, we avoid the issue of whether the present student population is the "right" population for the university. It avoids concern for all those people who could be university students, but are not, because they cannot afford to go to university, they do not have the proper motivational reinforcement, or their previous scholastic experience has prejudiced their acceptability to the university.

We believe that it is essential to conduct research on these issues; they are substantial areas of social concern.

Part II. System defined:

In his very useful essay on systems[1] Dr. Hills extracts from Richard Rudner[2] what the latter considers to be the minimum requirements for a scientific account of a system. It must include at least the following:

> "1. An identification of the components or elements of the system.
>
> "2. A specification of the aspects or characteristics of the components relative to which _states_ of the system are to be provided.
>
> "3. A specification of the set of laws in conformity with which states of the system succeed or precede each other, or with which elements of the system interact as regards the characteristics of the components specified in 2."

Hills claims that:

"Reduced to its minimum essentials, then, the referent of the concept of system is interdependence or order

---

1. _Hills_, R.J., "The Concept of System", Centre for Advanced Study of Educational Administration, University of Oregon, Eugene, 1967. Page 2.

2. _Rudner_, R.S., "Philosophy of Social Science", Prentice Hall Englewood Cliffs, N.J., 1966. Page 89.

among phenomena.....

"In addition to the element of order, three other components of the concept of system stand out. These are selectivity, abstraction and system state .

"System or order concerns the relations among the properties or variables utilized to characterize empirical entities and phenomena."[3]

Selectivity refers to the selection of variables relevant to the information required of the system. Abstraction implies that entities are treated in terms of their common rather than their unique properties. The state of the system is the description of the values of the variables it contains. For example, if the system contains the variables 'x' and 'y' and the 'x' and 'y' have orderly or systematic relations between them, when 'x' is specified, 'y' can be determined.

In establishing a system, according to Hills, "the investigator selects from a concrete situation capable of characterization in terms of an infinite number of properties, a limited set of properties common to a plurality of entities, the values of which are related systematically to one another or to other values of the same variable at a subsequent time."[4]

---

[3] Hills, op. cit., page 3.

[4] Hills, op. cit., page 5.

Hills goes on to define a structural system as one which consists of units with selected character properties as well as patterned relations among unit properties. A character property describes the kind of unit it is, while a unit property describes how it is measured. The structural order usually provides the basis for investigation of processes which go on within structures, and through which structures are either maintained or changed. This latter investigation is that of "process system"[5]. Thus the process system has a three-fold distinction: (1) stable processes which involve neither structural change or structural maintenance processes, (2) equilibrium maintenance processes which tend to maintain a given structure in the face of external variability and ([illegible]) processes through which a structural system undergoes change. While stable change processes seem to have few counterparts in human behaviour[6], equilibrium maintenance processes are relatively numerous.

---

5. Hills, op. cit., page 8.

6. Morgenau, H. and Smith, J.A., "Philosophy of Physical Science", in Guy S. Metraux and François Crouzet eds., The Evolution of Science, New York, Mentor. 196[illegible].

For example, consumers want change continuously requiring compensatory processes within the system which do not change the basic structure of the economy. Hills claims it should be apparent that the state of the educational system in relation to the consumers of its services might be conceived in parallel terms.[7] Hills goes on to say that the processes most characteristic of social systems would appear to be various forms of communication:

> "Communication may be viewed as a set of control (feedback) mechanisms involving several kinds of media, through which the values of the process variables are kept within limits compatible with the maintenance of the structural system. ...The expenditure of money can be conceived as a form of communication through which one unit controls the behaviour of another."[8]

This statement on social systems resembles that of Dorfman on General Systems Analysis:

> "General systems analysis or cybernetics is fairly closely related to information theory and indeed incorporates it. ...The separation of centres entails that no centre will have all the information available to the organization....and there will be delays in transmitting information to centres where decisions are made and in transmitting and executing instructions from executive

---

[7] Hills, op. cit., page 9.

[8] Hills, op. cit., page 9.

centres. This circumstance gives rise to the problem of systems analysis: to deduce from the structure of information flows in an organization and the decision rules employed by its various centres, how the organization will respond to changes in its environment and conditions. As a corollary, systems analysis is concerned with methods of ascertaining the information flows and decision rules in organizations—which often differ from those in the official organization chart—and with finding optimal information flows and decision rules.

> "The fundamental assumption of systems analysis is that all decision rules can be thought of as responses to discrepencies between the actual state or performance of the organization and some standard or desired state and are intended to reduce those discrepencies..."[9]

In the social sciences, the organization involved is often described as a 'functional system':

> "Functional system is that in which changes in the values of given variables have consequences for the other variables involved in the functioning of some system."[10]

Given these definitional statements on the concept of a system, Hills notes that in the field of educational administration, the lack of theory is at least as serious as the lack of much observational data about which to theorize.[11] Furthermore he states:

---

[9] Dorfman, R., "Operations Research" in, Surveys in Economic Theory, Vol. III, RES/AEA, London, 1965. Pages 39-40.

[10] Hills, op. cit., page 10.

[11] Hills, op. cit., page 13.

> "To speak of cataloging systematically available knowledge, however, implies that there is available a widely accepted categorical system in terms of which such an ordering may be accomplished. Categorical systems are necessary prerequisites to theory, and of course, theories are sources of sets of categories which may be used to order existing, and produce new knowledge. ....
>
> "The identification of structural order at a given level leads to further questions.....the identification of the constituent elements or an organization, combined with information about how they enter into combinations leads to questions as to why they enter into these combinations and not others....
>
> "The two great difficulties encountered in the study of organization structure have been (1) the lack of any widely accepted system for the classification of the unit and relational aspects of structure....and (2) the fact that more frequently than not, a particular commonsense structural unit....is studied in isolation."[12]

We shall see in the following discussion that these difficulties stem from the fact that some organizations lend themselves more easily than others to systematic conceptualization. Organizations such as universities which have not necessarily meant to be systematic for a variety of reasons, having to do with perception of need and the nature of their endeavours, would probably be more difficult to systematize than others. To impose systems on such organizations represents a major qualitative change in our perception of what they are and how they work. The very hypothesis that a university can or should be systematized is a matter that cannot be taken for granted. There are real difficulties involved, both conceptual and political. There are also advantages. We turn to a discussion of these in our identification of the system. We shall then discuss the choice of techniques that may be applied to "work" the sytem.

---

[12] Hills, op. cit., page 15.

Part III: Identification of Variables in the Educational Process.

We identify the components of the instructional system as *inputs* and *outputs*. The inputs are organized into *activities*. Activities are the basic elements of programs: lectures, conferences, tutorials, labs, corrections, and whatever other form of instructional process that is used in universities.[13] The inputs which interest us for this inquiry are *time*, *teachers*, and *students*.[14]

---

[13] *Boxus*, L., *Jadot*, J. and *Walckiers*, P. in "Essaie d'Application des Techniques PPBS à L'UCL", Louvain, 1969, page 33, makes the case for programme elements as detailed as the course level. We will discuss the reasoning behind this concern for detail in our comments on output concepts and costing variables.

[14] We leave space, equipment, administration and other areas to subsequent investigation.

These inputs interact in ways to be specified and yield educational output. The inputs have characteristics relative to which states of the system are to be provided. We discuss them in detail, one by one.

a) Time:

We characterize time as a quantity of hours that normally has a regular pattern of sequencing for any specified activity. This characterization impregnates the instructional process with organized regularity, or at least with a total explicit commitment of time that students and teachers expend on the activity, per academic year. It is a concept quite imperfectly adaptable to describe any activity which does not generally occur over a predictable and objectively measurable number of hours.

It also has the disadvantage of being particularly uninformative about the quality of what happens during that period of time. Unfortunately, educational activity is the kind of undertaking in which we encounter these problems. This is so largely for three reasons:

(1) Not all teaching is regular,

(2) Teaching activity is not a single input. Within

teaching activity there are differentiated functions, not all of which consume an objectively measurable amount of time, and

(3) Teaching is not a mass that assumes regular and visible alterations as a function of the time during which is done.

Typical of irregular teaching situations are discussions between teachers and students, or between students and students that have no formal place in a timetable. They may, nonetheless, consume a fair amount of time and affect the learning of the student. Furthermore, students engage in field or lab work in the preparation of papers, and they often do these activities at irregular and non-measured times. To the extent that new modes of instruction tend toward informality of arrangements and a much greater emphasis on "self help" on the part of students, it will become more difficult to say anything systematic about the time consumed in teaching. This problem affects costing to the extent that the time commitment per activity of the professor becomes obscure; however, the obscurity of student time commitment to an activity does not matter to cost only as long as we limit our concern to institutional expenses. To say anything about time in these situations would involve problems of reliable estimation of things that are difficult to verify objectively.

With regard to teaching activity—even though part of it which does appear to occur systematically, time measurement problems are involved. We differentiate teaching activity into the categories of preparation, delivery or discussion, administration and assessment. The amount of time which a professor spends on the preparation of lectures, administration of his course and assessment of students is obviously not objectively measurable and likely to be highly variable from one person to another and one situation to another. Provided the teaching activity is regularly scheduled, only delivery and discussion— that is, "contact hours" are objectively measurable. Sometimes administration and assessment are measurable. This occurs when assistants are employed to handle these functions and the time commitment, either as an average or maximum, is normally understood between the contracting parties.

The third problem involved in the time input is its inability to characterize the quality of what happens during the time spent. This difficulty has critical "efficiency" implications. If two teachers have the same objectives and one can reach his objectives twice as quickly as the other, either because he is a more "effective teacher" (however defined) or because he has "better students" (however defined), and we have no way of objectively assessing the extent and impact of such differentials, the value of any one hour in terms of what it accomplishes is indeterminate.

If we stick to the cannons of traditional scientific methodology and thereby use only objective and hence verifiable data, we are constrained to measuring activity in terms of contact hours; we must admit the inadequacies of this measurement which have to do with the general problem of using objective data to measure things which have subjective importance that is inadequately informed by the objective data. Using contact hours makes certain homogeneity assumptions that are not necessarily warranted by intuition of reality:

(1) Contact hours are homogenuous.

(2) The ratio between contact hours and the other functions of teaching carried by the same person is the same for everyone, per activity.

For example, if two teachers of equal objective description each give a course of similar contact hour duration and handle similar functions, we are assuming that their total time commitment is the same. This is what time comparison in terms of contact hours tells us. Needless to say, it is not necessarily true, but it is all we can say objectively.

To augment the description of the system with the characterization of the state of other inputs is of course necessary, but not sufficient to overcome this "objective/subjective" problem.

b) Teachers:

We characterize teachers, individually by rank and salary. In and of itself this characterization means very little. It all depends upon the interpretation the user wishes to read into this information relative to the objective for which it is used. Salary is necessary to incorporate because it is the essential component of cost.[15] The level of salary in conjunction with the rank of the teacher is assumed to be some approximative indication of his worth to serve the objectives for which he is there. It is debatable that these indicators are entirely trustworthy, and it is therefore clear that they cannot be relied upon exclusively to describe the quality of an existing activity, or that the detailed planning of future activity can be reliably undertaken at a level which is not sufficiently familiar with the individuals behind the rank and salary designations of the system.[16]

The literature on teacher-rating is particularly disappointing to anyone concerned with the problem of

---

15. In our partial analysis it is the only component of cost. Walckiers, (op. cit., page 35) estimates in the case of Louvain that teachers salaries account for close to 2/3 of operation costs. According to 1966, 1967, 1968 Gauthier Committee statistics, in Quebec universities it fluctuates between 45 and 52 percent, depending upon the year and the institution.

16. Professor Scheffield of the University of Toronto Institute of Education has undertaken a study, the objective of which is to define the characteristics of what makes a good teacher from the point of view of the graduated student. His study is at the questionnaire stage.

developing a set of objective and operational categories by which to describe teachers in terms of the qualities that contribute to their effectiveness. In speaking about the prediction of teacher success, Green informs us of the following problems:

> "Prediction calls for some sort of measurement yielding scores (or ratings, or categories) from which the prediction can be made. Such a measure, regardless of form, may be called a test. When the test scores of a group show a non-chance relationship, typically, a positive correlation, to their scores on another measure taken later, predictive validity for the first test may be claimed. The characteristics of the second measure, commonly called the criterion measure, are as important as those of the first test. It is the difficulties with criterion measures that have largely defeated attempts to predict teacher success.
>
> "The preceding statement suggests that no adequate measure of teacher competence has been devised...."[17]

Green goes on to comment that this conclusion is an affront to 'common sense', and many rating schemes have been undertaken. With respect to these, Green comments:

> "Bias, subjectivity and lack of reliability often plague any kind of research based on ratings, and the teacher ability studies are no exception, although care and foresight can do much to mitigate these difficulties. ...
>
> "One of the most important determinants of teacher ratings is the relationship between the rater and the teacher

---

17. Green, Donald Ross, "Educational Psychology", Foundations of modern Psychology Series, Prentice-Hall, 1964, page 40. This book constitutes a review of the literature and summary of the state of the art in the field. It is therefore our main reference in the following discussion.

being rated. Supervisor's ratings, students' ratings, self-ratings, and ratings by outside observers often disagree. ...

"The use of measures not originally designed to predict teaching effectiveness is another part of the difficulty. Tests like the National Teacher Examination, however, gauge professional knowledge, general intelligence, and knowledge of subject matter, and these are the logical foundations of teacher success. Yet scores on this test have not been shown to be related to ratings either."[18]

Green goes on to suggest that the logical criterion measures for teacher ratings are measures of pupil learning. Studies have been conducted and:

"In fact, the one clear unequivocal fact to emerge from these investigations is that whatever it is ratings of teachers measure, it does not include pupil learning. Teachers ratings are not positively related to pupil gain, they are not negatively related to pupil gain, they are unrelated to pupil gain.

"Moreover, logical though it may seem, attempting to find measures of teacher behaviour that have predictive or concurrent validity for student learning is not entirely sensible. What a student learns while he is in some class (from a teacher?) is partly a function of what he has learned in the past, and what he is concurrently learning elsewhere. ...

"Simple criterion test relationships are unlikely to be found even if satisfactory criterion measures are developed, since teacher behaviour is only one of the variables in student learning, all of which probably interact with one another. A few, notably pupil intelligence, are of such importance that their influence is not usually masked by the others, such as teaching personality, teaching methods, materials, class and school characteristics and so on. The available evidence strongly suggests that under normal circumstances teacher variables are not that powerful, and even more elaborate studies controlling more of these non-teacher variables will prove to be of little value."[19]

---

[18] Green, op. cit., page 41-42.

None of this changes the fact that people directly involved in the process have opinions and intuitions about the qualities of their teachers, and although the categories which describe these qualities are difficult to quantify in any reliable way, some attempts at categorization may be mentioned.

The students' society of the University of Montreal, in their 1967-68 course guide, suggested the following evaluative criteria with respect to the teacher:

a. Does he encourage student initiative?
b. Is he consistent and honest in his exams?
c. Does he voluntarily admit questions and respect the opinion of students?
d. Does his teaching correspond to the level of the class?
e. Does he make frequent use of examples and illustrations?
f. Does he inspire confidence in the class because of his competence?

---

[19] Green, op. cit, page 42-43. Dr. Malott of Western Michigan University suggests that one way to overcome the influence of other variables is to create educational experiences powerful enough so that the effect can be measured despite the influence of other variables. When standards are set at 95% mastery rather than 60% mastery, and when large classes are used, the influence of other variables may be averaged to concel each other out and the results would be reliable and predictable.

g. What of his sense of humour?
h. What of the quality of the structure of his course?
i. What of the use of new methods for approaching problems?
j. Does he encourage students to do their best?[20]

In the controversy following the publication of this document[21], there were few complaints about the categories chosen, however, the measurement procedure and statistical methods were harshly criticized. Alternative statistical techniques were shown to yield completely different results from the same data, and the issue of which technique was appropriate for which purpose remains inconclusive.

McGill University students[22] did not try to impose quantitative measurements on assesement. Their handbook gave qualitative, verbal description, and generally showed much concern with whether the professor was "dull and routine" or not, how well he organized his material, the quality of his delivery, his accessability, and sometimes the interest he took in supervising the activities of his conference leaders. Thus, despite the measurement problems involved in developing operational categories of teacher classification, it appears that student perception of teacher quality plays an important role in the welfare of the process conducted in the institution. It cannot be ignored, but it is a most difficult matter about which to be systematic.

---

[20] A.G.E.U.M., "Evaluation des Cours 1967/68", inside front cover, our translation from the original French.

[21] Most of this discussion appeared in several issues of Le Devoir and Le Quartier Latin in October 1968.

[22] Arts and Science Undergraduate Society, McGill University, Course Guide, 1967/68.

A good cause for an economist's concern with this state of affairs is its implications for efficient allocation. If the effectiveness of the teacher cannot be measured in terms of the attributes of the individual, it becomes difficult to find objective criteria by which to assign particular kinds of teachers to particular kinds of tasks. It may well be that an $8,000.00/annum man can do the same job as a $13,000.00/annum man *ceteris paribus*, yet unless we have some way of knowing this, it is quite possible to waste $5,000 on the simplistic hypothesis that the higher the salary the better the man for the job involved. An interesting case comes from one American jurisdiction where driving instruction was given to students both by expensive university-standard instructors and by much less expensive persons from private driving school firms. The students of the former did no better than those of the latter. In this case, however, benefits are measurable because of the nature of the subject being taught.

One can either drive properly or not, and criteria are not particularly obscure, as in other areas of learning.

Furthermore, university teachers are not hired and maintained solely on the basis of their teaching ability. Research is an important criterion in and of itself, apart from any effect it may have on their effectiveness and ability as teachers. Both the quality of research and the effect of research on teaching ability would be difficult to describe objectively. We do not know how research ability affects teaching ability, nor do we know that the two are even related. It may be that good teaching and good research do not involve the same intellectual qualities.

c) Students:

If the categorization of teachers is difficult, that of students is even more so. To some extent we may advance the hypothesis that students are partially "self-descriptive", in the course selections they make. We may generally expect to find a different sort of student in an honours or highly specialized activity, than in a general or introductory activity. It would be most desirable, however, to have more information to describe the student input. This is so because unlike stamped-out parts of unassembled automobiles, not all students come into the same activities with the same characteristics. Obviously university education is a "value added" process, because it does not start at zero. It builds on the material it has. The students come into the system with characteristics that affect their performance within the institution, as Green suggests in the above comments. We are interested in determining the difference the university experience makes to these people; this makes it necessary to know what it is that is being added to, and the economic exercise would be to compare marginal product with marginal cost. This implies the need for a set of student categories capable of objective description. The categories should inform us of the level of certain student characteristics as students enter the system, and how the characteristics change as they go through it.

It is conceivable that the institutional learning environment will influence student learning and personality development as much as any characteristics that are particular to the student. Factors that may matter in the environment are the extent to which the institution has an authoritarian, as opposed to a permissive legal and political structure. Physical constraints such as space and equipment may also influence the kind of learning experiences that students and teachers may share. We have not found a body of theoretical or empirical literature which discusses the impact of environment on learning, at the university level. We therefore discuss student characteristics as if they were to interact in no particular environmental context.

There are many student characteristics relevant to the learning process, and there are tests which psychologists normally apply to determine the state of these characteristics in any individual. The tests are experimental rather than routine.

Without good categories of student description, much of the benefit side of the cost benefit analysis (that systems analysis is meant to assist) will be obscure. While we have defined the student himself as an input, what happens to his characteristics as he goes through the university is output. Thus, the description of him both as an input and an output is strategic to the utility of cost/benefit analysis in higher education.

We discuss four general groupings of student personality characteristics that researchers in educational psychology have studied. The particular characteristics noted within each group are not exhaustive, but they are the ones which appear to have received the most attention by researchers. The four groups and their related characteristics are as follows:

(1) Inherent and physical variables:

a. heredity or genetic differences
b. maturational factors
c. prior experience

(2) Variables describing intellectual skills:

a. cognition
b. memory
c. convergent thinking
d. divergent thinking
e. evaluation

(3) Emotional variables:

a. anxiety
b. need for achievement
c. level of aspiration

(4) Cultural variables:

a. family background
b. socio-economic status.

(1) Inherent and physical variables:

There are certain personality characteristics inherent to the individual as he comes into the system which are not directly measurable, nor is it possible to isolate the influence of any one of them on the learning process. These variables are:

(a) heredity or genetic differences;
(b) maturational factors;
(c) prior experience.

It is generally acknowledged in psychological circles that heredity and environmental factors continuously interact throughout a person's life. The manner in which they interact in infancy affects the manner in which they influence each other in childhood, which in turn alters the possibilities of later interactions.[23] The importance of this to evaluation is critical. The most common evaluation is the I.Q. test, however, I.Q.'s cannot be assumed to measure one of these factors in isolation of the others and achievement scores do not only reflect differences in learning.[24]

---

[23] Anastasi, A., "Differential Psychology", Third edition, Macmillan, New York, 1958. Chapter 2, in Green op. cit.

Green goes on to say that:

> "To discuss intelligence as something other than those things measured by intelligence tests can only lead to confusion. Consequently, determining what intelligence has to do with school learning becomes a matter for investigation and experimentation, not a matter of logical deduction from a definition of intelligence. The most common measures of school learning—achievement test scores, marks, and the like—should be treated in a similar fashion. In other words, what they measure must be determined by research. A score on an achievement test usually represents many things in addition to what the student has learned in a particular course; indeed, it represents the sum of all his related learning experiences, whenever and wherever they occured in his life, interacting with his abilities and other characteristics. It is always fair to refer to such a score as a measure of performance, but only sometimes fair to refer to it as a measure of learning, especially when there is an implication that the learning took place at a particular time, such as during a given semester."[25]

A further complicating factor is that the object of education is not necessarily uniform. Goals differ, and therefore categories and evaluations are required to portray achievement with respect to particular kinds of personality development that occur in the university.

---

[24] Green, op. cit., page 7.

[25] Green, op. cit., page 7.

2) Intellectual Variables:

If we accept the notion that the university experience is meant primarily to develop intellectual processes in several disciplines over a period of several years, we should like to be able to measure the state of these processes as the student comes in, their state as he goes out, and then use these measures as an indication of what has been produced. We are fortunate in having a categorization of several intellectual processes, along with their general description and the tests that are supposed to measure their state of development.[26]

---

[26] A problem of particular interest to Quebec is that of the cultural context in which the tests are administered. To the extent that the tests are designed with a particular cultural context in mind, they may not be appropriate for both Anglophone and Francophone student communities. Their adaptation raises the problem of comparability which is important to inter-institutional comparison within the Quebec university system.

OPERATIONS INVOLVED IN INTELLECTUAL PROCESSES [27]

Operation	General Description	Sample Tests
Cognition	The processes in knowing, discovery, and recognition. Includes some reasoning.	Vocabulary, arithmetic reasoning, naming similarities between objects.
Memory	Retention of that which is cognized.	Memory span for number sequences, memory for word pairs.
Convergent thinking	Generation of new information from known and remembered information. Production of "right", "best", or conventional answers and solutions.	Completion of verbal analogies, arranging pictures in logical sequence.
Divergent thinking	Generation of new information from known and remembered information. Production of numerous, diverse, unusual, unconventional answers and solutions.	Listing objects with certain characteristics (Identical Fluency). Writing captions for cartoons (Originality).
Evaluation	Deciding about adequacy, correctness, or goodness of what is remembered or produced by thinking	Finding incongruities in pictures. Judging about identity of pairs of letter or number sequences (Perceptual Speed).

---

27. Guilford, J.P., "The Three Faces of Intellect". American Psychology, 1959, 14, 469-479, adapted by Green, op. cit.

One of the more important distinctions to be drawn from the table is that between "Divergent thinking" and the other operations. Tests of divergent thinking are thought to measure "creativity". According to Green, adults of proven creativity tend to score high on such tests.[28] One of the more serious educational problems discussed in various university forums is whether the university experience is as creative as it should be. It would be informative if we could assess this matter by applying tests of divergent thinking to university graduates of programs which have different procedural characteristics. We are unaware of any such attempts with university students. We could envision the problems of selecting a sample where _ceteris paribus_ conditions hold sufficiently to render the results meaningful. American tests, however, suggest that on the whole American schools tend to suit High Intelligence groups rather than High Creative groups of students.[29] Therefore, we cannot

---

28. Green, _op. cit._, page 14.

29. Green, _op. cit._, page 16.

rule out the possibility of developing ways of applying these measures to university input and output in aid of a scientific categorization of the educational process at the university level.

3) Emotional Variables:

To this point, we have talked as if only intellectual aspects of personality matter in education. Would that it were true, but Green informs us that non-intellectual aspects of personality (emotions, attitudes and motives) are part and parcel of differences in abilities, and are not really separable from the intellectual aspects of personality even though it may be useful to treat them as though they were.[30] This implies that the students come to the university with a certain state of non-intellectual personality characteristics which will influence how they learn and may be influenced by their learning experience. These things would be useful to measure. The main characteristics treated in the literature are (i) anxiety, (ii) need for achievement, and (iii) level of aspiration.

Green informs us that the relevance of these three variables to learning has been investigated as well as hypothesized, and in this research some reasonably reliable measures have been used.[31]

---

[30] Green, op. cit. page 16. Separating their influence would be required to isolate the specific contribution of the university experience.

(i) With regard to anxiety, Green concludes from a survey of the experimental literature:

> "It appears that anxiety level is an important variable in learning, and stable differences in anxiety among individuals exist. But unlike intelligence, whose relationship to performance is more nearly the same at all times and places and for all materials, anxiety has different relationships to performance and learning for different materials and different situations. High anxiety generally, but not uniformly, handicaps performance."[32]

We consider this statement inconclusive enough to discourage categorization of students by anxiety level, however measured, until psychological research yields hypotheses that are both more precise and capable of generalization.

(ii) Need for achievement may be measured by a device (among others) known as the Thematic Aperception Test. Experiments undertaken by McClelland, Sarason and others lead Green to make the general statement:

---

[31] Green, op. cit., page 17.

[32] Green, op. cit., page 18.

> "That these TAT scores yield relationships to behaviour that show substantial variation from situation to situation and from group to group can be taken to mean that the instrument is useless; but it also can be taken to mean that a single motive will influence behaviour at different times and places and differently in different people because of variations in other functioning motives. The latter position seems more reasonable as well as more complicated than the former."[33]

It also makes it difficult to assess the utility of describing students by performance on these projective tests throughout a university system if the results are so dangerous to generalize. Yet they do indicate that need for achievement matters to learning. The nice point is how much and in what context.[34]

(iii) Level of Aspiration tests have been applied to university students and the correlations have been significant.[35] The subject is asked to predict his performance or state his goal before each trial on some task. Attention has centered on the discrepancy between the subject's stated expectations and his immediately prior performance. According to Green:

---

[33] Green, op. cit., page 19.

[34] The reader interested in following up the practical importance of the TAT may consult Prof. de Ritter, "The Personality of the Urban African in South Africa", Routledge and Kegan Paul, London, 1966, where the results of application of the TAT to candidates for employment as bus drivers in Cape Town clearly indicate how the institution of apartheid affects many aspects of personality of oppressed and deprived African populations.

[35] Worrell, L. "Level of Aspiration and Academic Success", Journal of Educational Psychology, 1959, 50, 57-64, quoted Green, op. cit., page 21.

> "The advantage of this approach lies in the direct relevance of the measure to goals defined by the situation in contrast to hypothetical and ill-defined needs and drives."[36]

Worrell's statistics indicated that the more nearly the student's thought their work was up to their capacity and the more nearly their standing was about what they called satisfactory, the higher their grades tended to be. When combined, the various discrepancies between the aspiration estimates had a closer correspondence to achievement than did aptitude measures. These results seem to suggest that level of aspiration ratings may be a useful category by which to describe the state of student input. While these comments seem to imply a causal relationship between need for achievement and success, it is also possible that need for achievement is a function of other variables—of which previous success, family background and the "progress orientation" of the cultural milieu may be some.

An important additional fact which must be considered is that the experimenters found sex differences to be very noticeable in studies of anxiety and achievement. Green informs us that:

---

36. Green, op. cit. , page 20.

"These male psychologists seem to find the behaviour of women awkward to explain." [37]

It could be that when these studies were conducted, fewer women attended universities. It is possible that the novelty and numerical unimportance of women on campuses produced behavioural characteristics that tests designed for the predominant male populations could not detect.

4) Cultural Variables:

Other than intellectual and non-intellectual personality characteristics susceptible of influencing the educational attainment of the student, we must briefly mention cultural differences in relation to learning. The abilities, attitudes, interests and values which students have acquired are products of learning; the home, neighborhood and nation exert pressures on students to learn some things and not others. Experiments cited by Green[38] all indicate reasonable correlations (approximately .5) between I.Q. of parents and school performance measures.

---

[37] Green, op. cit., page 22.

[38] Green, op. cit., page 24.

They have also discovered that for able high school students, the proportion hoping to go to college is twice as large among those whose parents want them to go as among those not so urged. Thus, family background is one of the factors which explains why children of 'middle class families' are so prevalent on university campuses.

Opportunities to learn are a function of socio-economic status, and the relationship between socio-economic status, I.Q. and school achievement is substantial.[39] The ranking of socio-economic status may be made on objective criteria such as parental occupation, or subjective criteria such as ratings of social position by other members of the community. The objective criteria is easier to incorporate into systems categories. It could be that by the time students are accepted to university, this variable becomes irrelevant to consider in an assessment of their progress. It may be a useful variable to include for the broader social purpose of indicating the extent to which pre-university education through the school system counteracts the effects of lower socio-economic status in holding these students back from university admission.

---

[39] Green, op. cit., page 24.

If the universities are interested in democratizing access to university, it must take a global view of student population. This global view would encompass "youth" rather than student population defined according to the present norms of admissability to universities. When the issue of student population is cast in this frame of reference, the universities would then become actively interested in how the primary and secondary school systems are facilitating their interest in accomodating students from a wide socio-economic spectrum.

Our discussion on ways of classifying student input has focused on our concern that the chosen categories should inform on the intellectual and non-intellectual personality characteristics as well as the cultural factors that describe the individual as he comes into the system and that affect or will be affected by his education as he goes through the system. The purpose of this method of classification is to inform our judgement on the ways and the extent to which university experience makes a difference to the students involved.

The general problem we encounter is that learning is influenced by all of the variables at the same time, which makes it very difficult to isolate the effect of university education on the state of intellectual variables, partly because some of the other variables are either non-measurable or their degree of inter-relatedness is not easily distinguishable, and partly because some of them lack generality and predictive ability. Malott's suggestion to create extremely powerful educational experiences may help to mitigate many of these uncertainties. At present, though, this raises the general question of whether or not it is useful to include some variables in a system but not others. On the one hand, such a procedure could be seriously misleading. On the other hand, it may be more informative than including nothing at all, as long as the interpretors of the data are aware of the shortcomings. It is unquestionably a rather massive undertaking to build a system which includes even the most credible of these variables, and it is not the task of economists. This in no way implies that it shouldn't be done. That we have not built any of these variables into the present project is only a reflection of the present state of our competence and resources. For now we use a classification of students by course, fully aware of the difficulties involved in imputing meaning and comparability to such a classification. We are unaware of any systems analysis at the university level which has gone further.

IV. Learning Processes:

We noted on page 47 that the inputs described combine in various ways to yield output. When economists analyze industrial production, they describe the inputs to the process, then how the inputs combine to yield output. To do this they must understand the essentials of the process. The relative efficiency of alternative processes cannot be assessed without this minimal understanding. In our field, the analogy implies that we must understand the factors conducive to learning if we wish to assess the efficiency of any one process over another to reach specified objectives. We thus define what learning is, and then the factors which facilitate learning.

Green suggests a general definition of learning:

> "....When an individual engages in practice and training activities and when observations of his performance indicate that performance has changed, learning is usually assumed to have occured.
>
> "....When one considers the variety of performances that can be observed, the variety of changes that can occur, and above all, the variety of conditions surrounding practice that can exist, any apparent simplicity of this description quickly evaporates." 40

Green suggests that in discussions of learning it is convenient to distinguish between (i) learning the conceptual structure of a subject— acquiring a knowledge and understanding of its principles and meaning— and, (ii) learning to use this knowledge in thinking and further learning— developing an ability. Thes categories roughly correspond to those listed on page 22.[41] Knowledge in this context means cognition and memory; Ability refers to the substantial use of operations involving convergent and divergent thinking as well as evaluation. Schooling and the development of ability do not have to be the same: The development of ability cannot proceed unless the subject matter has meaning to the student. Meaning is a function of association. Some meanings result from chance associations in daily life,

---

40. Green, op. cit., page 59.

41. Green, op. cit. page 56.

others belong to the structural categories of the subject into which the material fits, and others are derived from the relationships among the elements of the category to which the material is assigned.

. Meaning facilitates retention and transfer. Transfer refers to the consequences of prior training on learning. Thus, the more meaning one can bring to learning, the more efficiently the new learning will proceed. The facilitating effect also depends upon what kind of organization and structure has been imposed on the material. In the early stages of learning, the ability to make use of prior learning may be almost nil, however, this ability should develop as learning proceeds. But Green informs us:

> "....Since a major difference between high and low intelligence is the ability to use learning, school learning and the development of intelligence would seem to be pretty much the same thing. Yet somehow, a high school diploma, a college degree, or a graduate degree does not guarantee brilliance or even common sense."[42]

We assume that one of the more important objectives of university training is generally to impart ability, yet we are informed that people can and do go straight through the system developing knowledge and little more. This implies the existence of inefficiency or wastage of resources. Both prior training and the approach adopted by the educators matter as to the kind of education the student will acquire. Approaches vary between the degree to which students are encouraged to learn by rote, to understand the conceptual structure of the subject, or to develop their various abilities. We should thus be interested that pedagogic efficiency is assured in the sense that the approaches adopted are consistent with the stated objective. If there exists a choice of possible approaches to reach the same objective, and if staff and students are indifferent between some of the, the economic exercise is to calculate which of these is least costly and use it. The road ahead is to define what makes for effective teaching arrangements, then to describe the extent to which these factors can be categorized into a system and costed. This latter task is akin to the third minimal requirement of a system as described on page 40 of this chapter:

---

[42] Green, op. cit., page 52.

> "A specification of the set of laws in conformity with which states of the system succeed or precede each other, or with which elements of the system interact as regards the characteristics of the components specified in 2."

To define what makes for effective teaching arrangements we will have to describe the essentials of the learning process. The immediate problem is that of establishing cause and effect relationships. An examination to test for what students learn in a particular course or program does not only indicate what happened as a result of the particular instruction given, because the effect of prior training are important, as well as the effects of concurrent activities and non-school learning. This problem is an important one in the university context because there has been much prior learning before the student reaches the university, and there may also be much concurrent learning in related courses and non-scheduled activities of an academic character. It is, therefore, most difficult to systematically isolate value added to the educational attainment of the student by participation in any particular schedules activity which consumes financial resources. One way to mitigate this problem may be to create a control group and an experimental group in a class, administer a pre-test to the experimental group and a post test to both groups, then isolate the value added by the comparison of test scores from both groups. Difficulties in this approach may arise on at least two accounts:

(1) Evidence of short-term mastery may not be a reliable indicator of long-term retention and future performance.

(2) The test must be designed to test for the kind of learning that occured. A test which examines for mastery may not be useful to measure ability and vice versa.

It appears for now that assessment will necessarily be approximative and the standard of assessment in the university sphere, no matter how the assessment is administered, may be partly subjective. This is so because we do not possess reliable objective assessment techniques for all subjects that test not only for knowledge, but also for ability. With this caveat we proceed.

Transfer of training is the study of how partially developed abilities are further developed and how a number of abilities of limited scope are organized or synthesized into larger broader abilities.

C.H. Judd developed the theory of generalization. In his experiments he discovered that students learn specific material better if they are informed of the general principle that underlies it. The term generalization refers to three situations: the principle itself, the process of extending it to cover a new situation, and the process of deriving the principle from experience. The interaction of generalization and specific concrete experience he claimed to be the essence of transfer.[43]

E.L. Thorndike and R.S. Woodworth developed the theory of identical elements. In sum:

> "Improvement in any single mental function need not improve the ability in functions commonly called by the same name... Spread of practice occurs only where identical elements are covered in influencing and influenced functions."

They also wrote:

> "These experiments show very clearly the influence of the acquisition during special training, (1) of ideas of method and habits of procedure and also (2) a facility with certain elements that appeared in many other complexes."[44]

---

43. Green, op. cit., page 63.

44. Thorndike, E.I. and Woodworth, R.S. "Educational Psychology", The Psychology of Learning, Vol. II, Columbia University, 1913, quoted in Green, op. cit., page 64.

Thus, it follows that a device which increases the number of identical elements in the training and transfer situation will tend to increase transfer effects. Green adds that the theory is not generally applicable because methods appropriate to the study of one discipline may not work in another. For example, skimming for a general idea in literary reading may be quite unproductive in learning from a mathematics text. Thus, the merits of the theory are also a source of its weakness.

Of interest to psychologists in later periods were the transfers involved in developing general learning abilities (i.e. teaching students how to learn). Psychologists have discovered from experimentation and observation that after the early years of high school the kinds of learning activities expected of students remain relatively constant. The individual may continue to acquire knowledge, but the abilities called for in its acquisition change little. Green explains that most of the basic learning sets formed in school normally stabilize by the end of elementary school, and their organization into patterns of abilities is pretty far along. However, knowledge continues to be acquired, thus the range of areas in which abilities can be used continually grows.[45]

---

[45] Green, op. cit., page 69.

A critical implication of this hypothesis for efficiency of learning in the university, is that the most important factors which account for how people learn are beyond the direct control of the university. They are developed quite some time before the student ever reaches the university. Not all university teachers are insensitive to this problem. There are those who perceive that many students enter university with inadequate training in basic abilities of study and reading. They therefore offer university courses in an attempt to remedy this situation. It may perhaps interest school boards and the university to develop serious collaboration on the improvement of transfer of training at the elementary and high school level. Other than this, the university is essentially engaged in the transfer of knowledge and ability within a group of specific disciplines or areas of study.

The principle factors involved in the transfer of knowledge and ability are:

(1) A framework of assimilation
(2) Instructional set
(3) Attitudes
(4) The Law of Effect
(5) Reinforcement
(6) Knowledge of results
(7) Task and motivation
(8) Reward and punishment
(9) Motivation in classroom groups.

The first three may be referred to as factors that describe the student's "set", while the remainder are aspects of reinforcement.

In lieu of a detailed discussion of each of these factors, we summarize the conclusions which are obviously important to an economist concerned with the relevance of process efficiency to cost structures in the university.

(1) Framework of Assimilation: A background of relevant concepts, inclusive and abstract enough to be fitted to new material is helpful. The learner has a framework around which to assimilate, understand and remember new knowledge.[46]

(2) Instructional Set: There is dispute in the literature as to whether it is more beneficial to direct students how to proceed to organize and structure material, or to allow them to learn by discovering principles and working out problem solving procedures by themselves.

---

[46] Green, op. cit., page 70.

(3) Attitudes: From studies by Bostrom and Festinger,[47] the roles played by knowledge and instruction in the modification of attitudes can be large and difficult to foresee. Deliberate attempts to alter emotionally charged views by education requires considerable ingenuity.

(4) The law of effect is described by Thorndike as follows:

> "To the situation, 'a modifiable connection being made by him between an S and an R and being accompanied or followed by a satisfying state of affairs' man responds, other things being equal, by an increase in the strength of that connection. To a connection similar, save that an annoying state of affairs goes with or follows it, man responds, other things being equal, by a decrease in the strength of the connection.
>
> "The laws of connection forming or association or habit furnish education with two obvious general rules:— (1) Put together what should go together and keep apart what should not go together. (2) Reward desirable connections and make undesirable connections produce discomfort. Or, in combined form: Exercise and reward desirable connections: prevent or punish undesirable connections."[48]

The apparent simplicity of this statement is complicated by the difficulties involved in defining what constitutes reward and punishment situations. Thorndike

---

47. Quoted in Green, op. cit., page 72.

48. Thorndike, E.L., Educational Psychology, Columbia University, 1913, Volume II, page 20.

admitted this problem.[49]

(5) Reinforcement is the relationship between behaviour and its consequences and is one of the most important topics in psychology because reinforcement is one of the strongest and most immediately visible influences on the course of learning. The basic argument in psychology concerns which things may be called reinforcers and why they function as they do. In studies of school curricula, Skinner and others have critized the use of negative stimulation (criticism, punishment, low marks), the frequent absence of knowledge as to when an answer is correct, and instruction being poorly programmed.* To avoid some of these difficulties Skinner has recommended the use of teaching machines and programmed materials. The experimentation with programmed learning has yielded somewhat inconclusive notions as to what precise effect it really has on learning.[50]

---

[49] Green, op. cit., page 74.

* Programming means that a sequence of steps is worked out such that each step makes the next one relatively simple.

[50] Green, op. cit., page 77.

(6) Knowledge of results: Research has been quite consistent on validating the notion that knowledge of results enhances learning. Green reports:

> "When a student obtains information about the adequacy of his responses, learning in almost all kinds of situations for all kinds of students is better than when it is lacking. Furthermore, the more immediate the knowledge or results, the more reliable its effect on learning."[51]

and:

> "One of the major differences between meaningful and meaningless materials is that with the former the student can tell if his response makes sense. If he understands, he can see that what he has been doing is sensible and consistent with prior learning, and further direction of his activity is fairly clear. In meaningless learning, right and wrong are arbitrary and unknown to the learner unless someone supplies that information. Thus, the more meaningful, well-structured, and organized the materials of learning can be made, the greater the degree to which learning can proceed under self-direction without the teacher's intervention."[52]

The economic importance of this observation is obvious. The better the teaching arrangements, the less it need cost because costly human inputs may be minimized, and the more satisfactory it is likely to be for the students and staff.

---

51. Green, op. cit., page 78.

52. Ibid.

(7) Task and motivation: Experiments and studies, among which one by Grimes and Allinsmith[53] showed that:

> "An important factor in teaching methods is the matter of selecting, organizing and arranging the materials. The structure of the content chosen limits the kind of contingencies for reinforcement that it is possible to arrange. A particular arrangement is more likely to be effective with some students than with others because differences in needs create differences in the motivating effects of the reinforcement that can be given."[54]

The nature of the experiment was to rate students by anxiety and compulsivity, and then to teach them in a structured and an unstructured program. High compulsive students are emotional and tense in disorganized situations and work very hard to achieve order and conformity with standards. They found that in the structured school, the high anxiety high compulsive students did best. Need, and the kind of materials available went hand in hand ; therefore, high drive level was facilitating.[55]

---

[53] Grimes, J. and Allinsmith, W., Compulsivity, Anxiety and School Achievement, Merrill Palmer Quart., Quoted in Green, op. cit.,

[54] Green, op. cit., page 83.

[55] Green, op. cit., page 82.

(8) Reward and punishment: As motivation is fundamental to learning, it is important to choose the "reward and punishment" characteristics which yield the desired motivation. Green observes that in middle class society the assessment of achievement is probably an inevitable motivating factor in learning. However, many teachers deplore the fact that students work for marks rather than to learn. If grading systems are to be maintained, the amount of specific information given in assessment should be as great as possible because this has been demonstrated to motivate further learning. The system of grading should motivate learning as much as possible. Experiments with groups of students whose work was assessed with free comments showed that the free-comment group did consistently better. Apparently constructive comments have motivating consequences that cause more efficient learning.[56] The economic importance of this factor is that "time costs money" and if the additional time committed to the proper assessment of student work yields substantial improvement in learning, then the cost of such time consuming procedures may be justified depending upon one's view of the benefit of better learning.

---

56. Green, op. cit., page 87.

This discussion of assessment assumes that teachers assess students. New methods of instruction emphasize self or group evaluation as part of the learning process. To the extent that these exercises are no more time consuming to students than other arrangements, or if student time is valued as a free good, as it may be in institutional analysis, the the same motivation from specific evaluation will be derived at little additional expense to the university. There is need for intensified research on rating teachers and students at the university level.[57]

(9) Motivation in classroom groups: Green informs us that:

> "A classroom is an organized social group with many lines of social action between individuals. Students reinforce and motivate each other;"[58]

Clearly, if the organization of the classroom were conducive to greater motivation, learning efficiency would improve. Two organizational variables are mentioned, one

---

57. McGill University's Centre for Learning and Development is currently engaged in a teacher rating project. Members of the Centre Staff also presented papers on pass-fail systems at the Conference on Learning in November 1969.

58. Green, *op. cit.*, page 87.

being the degree of homogeneity of the group, the other its size.

Different tests have yielded contradictory conclusions about the learning effectiveness of homogeneous or heterogeneous groups of students.

In problem-solving groups, heterogeneous groups have been seen to produce better results than homogeneous groups. The heterogeneity of the group is conducive to more stimuli and the consideration of more alternatives. With regard to group size, Green states:

> "When groups get quite large a majority of the group may become more or less inactive, and it becomes necessary for one or more individuals to assume leadership roles. These people then become major sources of reinforcement.
>
> "In the typical classroom, of course, the teacher usually assumes this leadership role."[59]

However, this presupposes that the teacher is competent to arouse the curiosity of the students for the task at hand, that he has skills of clarity, novelty, and he is able to introduce surprise, change, and difficulty into the material.[60]

---

59. Green, op. cit., page 88.

60. Ibid.

> Group dynamics methods stress the involvement of all members of the course in an educational experience which relies on a great deal of self-direction, communication, and stimulus from animators. Class decisions and responsibilities are arranged so that everyone has some important role to play.[61]

The economic importance of these observations is that of balancing the economies of group size with the effectiveness of teaching. If groups are to be large, then the teacher is likely to assume the leadership role and good teachers spending enough time to perform this role effectively in each course may be costlier than mediocre teachers who spend little time in course preparation and delivery. If groups are smaller and less teacher-oriented, while the dollar value of the teacher-input may be lower, unit cost per student may be high because of the small number of students involved in the group. There are two considerations to weigh:

---

61. see. "La dynamique des groupes appliques dans une classe d'adultes", Robert, G.; Royer, D.; Tellier, Y. Ministère de l'Education et Les Editions de L'Institut de Formation par la Groupe.

(1) A measurable variable: is unit cost per student higher in small groups that are slightly teacher-dependent or in larger groups that are heavily dependent on excellent teachers who devote substantial amounts of time to their courses?

(2) Which arrangement is more effective in the particular context, and is the difference in effectiveness worth the difference in cost if the two are positively associated?

Having summarized factors which account for the learning of knowledge and ability, we must turn to the field of research on instructional procedures to try to assess whether some procedures are generally more effective than others, and deduce the economic importance of one procedure over another. While the former discussion seems to yield auto-suggestive notions about procedures, Green informs that the following statements from R.M.W. Travers are equally well supported:

"(1) Differences in achievement of pupils exposed to different teaching methods are small and not generally consistent from study to study.

"(2) The method considered to be the experimental method in particular studies tends to show some slight superiority to the method described as the control method.

"(3) When teachers are asked to teach two classes by different methods, the teachers show only limited capacity for changing their pattern of behavior as they switch from method to method. This fact may account for the small differences between methods found in some of the studies.

> "(4) Very few studies provide data indicating the way in which one method of teaching differs from another. Research workers usually report how the methods are alleged to differ, but few studies provide data indicating how the methods actually differ in terms of the recorded behavior of the teachers in the classroom." 62

Since the previous discussion seems to contradict hese statements, an explanation of the apparent paradox is in order. Green offers the following explanation, which has to do with methodological problems:

(1) Studies of learning normally measure specific and immediate outcomes, whereas the methods studies tend to measure general growth in a subject area.

(2) Learning studies usually examine student practice activity while methods studies have rarely described it or tried to control it.

(3) The word "method" is vague. Some studies have defined methods in terms of content and goals of the material. This is a philosophical issue, while teaching technique is not. This latter concept defines how teachers attempt to influence student activity, holding goal and content constant. 63

Attempts have been made to correlate method with achievement, intelligence and personality of the student. We discuss the conclusions of some of these studies because they are

---

62. Travers, R.M.W., "Essential of Learning", Macmillan, New York, 1964. Page 4. Quoted in Green, op. cit., page 91.

63. Green, op. cit., page 91.

relevant to issues of how methods may be selected, which in turn incur costs to the university.

The main problem involved in determining the effect of method on achievement is that of defining the priorities of achievement. There are different criteria of achievement (speed, accuracy, direct learning, transfer) and different methods may produce differential effects on these criteria. Thus the determination of the most appropriate method depends on value choices which usually require compromise.[64] What is of great interest to us though, is that different methods have produced differential effect on the different aspects of achievement, so that method does not appear to be inconsequential.

If we work on the hypothesis that, to the university, transfer criteria are the most valid, then we must examine the problem involved in the role of intelligence in transfer. Transfer is facilitated by intelligence. Transfer is also greatly facilitated by careful sequencing of the material to be learned. It would follow then, that careful planning reduces the role of intelligence. According to Green:

---

[64] Green, op. cit., page 93.

> "....when a careful sequence is not set up a learning task becomes a puzzle and it takes more intelligence to solve that puzzle.
>
> "For this reason, the learning of well-programmed materials should show a lower relationship to intelligence than do poorly programmed materials."[65]

This relationship has been found in several studies of programmed versus non-programmed instruction.[66] Two conclusions may be drawn from this: (i) Programmed instruction is good because it increases learning efficiency which is especially helpful for less intelligent students. (ii) Programmed instruction is no good because it inhibits the student from practising the maximum use of his learning abilities. It is therefore possible that the objective of developing certain abilities may conflict with the objective of acquiring knowledge. This problem is essentially one of determining objectives of education and choosing methods to be consistent with the objectives. If both objectives are important, then more time will be needed in the learning process and this will have to be paid for.

---

65. Green, op. cit., page 94.

66. References to these studies are in Green, ibid.

In a study by L.W. Towner, it appeared that differences in test scores among freshmen and sophomores were largely in quantity of facts known, while differences among seniors were more typically in the degree of generality and organization of this knowledge.[67] He also mentions in concluding comments on the work of Towner that:

> "It will surprise no one that as students get fairly advanced in an area, approaches that permit them greater freedom and self-direction in their learning become increasingly helpful."[68]

They may or may not become increasingly expensive, depending upon the configuration of student numbers and professional time involved. The interesting variable is that of the approaches involved. If the approach involves large classes, little university-paid evaluation procedures, and a minimum amount of lectures from university-paid staff, then greater freedom and self-direction is economical. However, greater freedom and self-direction need not imply this configuration of time and numbers. It may imply small enough groups to facilitate the kinds of student interactions that could

---

67. Towner, L.W. "A Factorial Investigation of Medical Students Knowledge of Cancer at Different Levels of Training." Educ. Psychol. Measmt. 1957, 17. Quoted in Green, op. cit. page 95.

68. Green, op. cit., page 96.

improve the efficiency of self-direction. It may also increase the need for university-paid evaluators, if the efficiency of self-direction improves with knowledge of where one stands with respect to the task at hand. We discussed above how learning is often improved by testing procedures which offer constructive and detailed advice on results. Clearly this configuration of time and numbers could be quite expensive. Unfortunately for economists and systems analysts there is no unique and timeless 'right answer' to these choices. Much depends on the specifics of each situation. The only hope for systematic procedures would be to be able to systematize the specifics in terms of their characteristics, match each situation with its 'best' technique and calculate the cost. Research in educational psychology will have to proceed considerably to make this possible.

One of the more important specifics that changes from one situation to another is that of the personalities of the students. Those of us who would find it most convenient to have straightforward generally valid conclusions regarding the kinds of methods that are efficiently related to different personality characteristics of students will be upset by the following:

"Although the authors report that a second study indicated students who think the instructor should be authoritarian tend to do poorly in independent study, a number of other investigations have failed to find any difference among groups who have and have not been allowed to follow the procedure they preferred. Thus, personality influences both preferences for methods and the activities a method elicits, but preferences are related to achievement only some of the time.

"The numerous studies of lecture versus discussion versus independent study for college students have failed more often than not to produce important differences in achievement. In the face of the sort of conflicting needs among students just illustrated, it is difficult to see how a teacher, even one who knew his students well, could make intelligent choices of instructional procedures according to student personality; it is easy to see, however, why the effects of the teacher's choice of method so often balance out, so that the net result is no different between groups taught by different procedures."[69]

Aside from the methods (objectives, content, material, and kind of student practice wanted) efficiency of learning may also be influenced by the technique the instructor uses to communicate the material. Technique is not completely independent of method because certain methods preclude some techniques. However; according to Green:

"The basic principle involved in teaching technique is that regardless of what a teacher does it is the student's activities which determine the course of learning. Having determined what he wants his students to do, half the teacher's task is done. This half calls for choice among methods. The remaining half is to get the students to do it. As a rule this can be accomplished in a broad variety of ways, and there is no reason to assert that one teaching technique is better than another, provided students in fact carried on the desired activity." 70

---

[69] This discussion is adapted from Green, op. cit., page 97 in reference to a study by W. Loenig and W.J. McKeachie: "Personality and Independent Study". J. Educ. Psychol. 1959, 50, 132-134.

We cannot entirely agree with this statement in light of what we have said in Chapter One about the welfare of different groups within the institution. Clearly if two techniques are capable of eliciting the same results and at least one group prefers one technique while other groups are indifferent, the welfare of the community would be improved by the selection of the technique preferred by the group in question.

The statement also seems at odds with much of the preceding discussion on the possibility that different techniques can have different results with different people, that motivation can be influenced by technique, motivation is fundamental to learning, and method is not independent of technique. We learn , however, that the basic inability to say very much about methods stems from the paucity of research that has been conducted in the field:

"For the investigation of techniques, information about the cues, direction, and reinforcements occurring in relationship to student activity must be obtained. Since it

---

70. Green, op. cit., page 98.

is evidently desirable that students have considerable freedom to control their own learning in the later stages of progress in any given area, the investigation of teaching techniques at this level is hampered. However, some crude but potentially effective devices have been known for a long time. For example, students can be asked to describe or keep notes about their activities as they proceed with their learning. Classes can be filmed and taped. Students can be shown these films or hear these tapes and can be asked what they were thinking about or doing at a given moment. It should be possible to analyze the notes and drafts as well as the final versions of papers that students write. The small handful of studies of this sort that have been done indicate that some valuable information could be acquired using such techniques, but they are too few in number for any generalizations to be made at the moment."71

In sum, our discussion of process had the purpose of trying to define how learning occurs and how learning may be made to occur with maximum efficiency. We asked ourselves what factors are more conducive to learning than others. Were it possible to make general statements about production relations, we could define these relations physically and then attach costs to these factors so that an economic choice could be made between technically efficient alternatives. We have encountered two substantial problems that hinder us in the accomplishment of this objective:

(1) It is very difficult to generalize from one learning situation to another because there are so many variables that affect each situation. Perhaps the most important

---

71. Green, op. cit., page 99.

of these variables is the heterogeneity of personality characteristics and prior learning of students. Another reason why generalization is difficult is that of the relatively little received doctrine in the field of educational psychology. While "received doctrine" is dangerous to the relevance of any science, the science must embody a certain number of operational and trustworthy hypotheses to be useful in educational planning. Generalization can only go as far a systematizing descriptive categories as mentioned on page 52 above. Improved theories will yield better categories, so the system would continually adapt to the current state of the art.

(2) We have defined the principal factors of production in the partial analysis as students and professors. We have associated cost only with the latter because we are primarily interested in analyzing cost to the university. Students and professors combine in different proportions over differing periods of time for any one activity, and the unit cost per student is derived from the particular configuration of time and numbers involved. The fact is: it is not simply the combination of people that produce the output. It is what happens between these people when they come together that makes the difference.

And it is what happens between these people when they interact that badly needs a set of systematic descriptive categories. We have also seen that it is difficult at the present time to apply general and objective measures (either quantitative or qualitative) to assess the contribution of the university experience to the relevant facet of education. These factors combine to yield the singularly frustrating problem that the descriptive and quantifiable aspects of the production of education, in their present state, are not properly informative of the process used and outputs attained.

In face of these problems: lack of generality, as well as limited relevance of quantification and lacunae in descriptive information about process and output measurement, we must face two further issues: (1) How should production be described in the most general way possible? (2) Of what use will this description be?

(1) We may describe production for the time being according to the form that it assumes. University departments generally know whether the form of the instruction they give in any activity is that of a lecture, a conference, a tutorial, a private discussion, a laboratory period, or other

similar arrangements. We are fully conscious of the fact that form does not describe content and that systems analysts should combine with educational psychologists to create a set of categories that professors and students would find convenient for the purpose of identifying their methods and techniques in each activity. For now, however, when the formal categories chosen are quantified by the numbers of students, staff and cost of staff associated with them,cost is calculable, but benefit is obscure.

(2) The use value of such a description is simply to give people who need the information a systematic and consistent way of assessing the relative costs of different teaching arrangements.

To use this information as a unique criteria of decision making would be irrational. We emphasize this point because when a system is described in terms of a set of categories, no matter how much these categories leave to be desired, they have features of organizational tidiness, scientific appearance and availability of categoric (but insufficient) measures which are attractive to decision makers who are bewildered by the amorphous nature of their concerns, and would like nothing better than a concrete, decisive and apparently rational frame of reference.

No financial manager wishes to create the impression that he is a spendthrift. Therefore, it would be immediately tempting for these well-meaning individuals to prefer the least costly solution with the good intention of saving money, either for the Minister of Finance or for the Administration of the university. Precisely because of the fact that benefits are heretofore illusive, intuitive and descriptive, while costs are concrete, objective and quantified, it is superficially easy to argue for minimal cost solutions. When the benefit side of the calculation is tangled between a series of objectivity unknown qualities, the definition and measurement of output in particular, it is seducing to equate the unknown with the non-existent and say that since it makes no difference after all, let us do what costs the least.

The considerations we have raised in the foregoing discussion of the learning process should reflect on the vaccuous character of this kind of thinking wherever it does or may at some time exist.

We have seen from the evidence of results that the choice of methods and techniques is not a matter of indifference either to the kind of learning intended, or to the extent of learning of any kind. The problem of educational psychology, if we may speak of a problem, is not that the field is impossible, but that it has developed categories, procedures and theories which require extensive testing and further development to become more precise and more generally operational at the same time. The learning categories of educational psychology have the unique advantage of articulating a description of intellectual development that has the potential of far greater meaning and objectivity than measures of output which are restricted to consideration of exam marks in courses followed by students. It also has the potential of defining the conditions of learning efficiency in different situations which will be objective and exact in the kind of way we like information about costs to be objective and exact. It would then be possible to have informed cost-benefit discussion at many levels in the academic and para-academic community.

The logical conclusion of these comments is that the description of the instructional system should incorporate categories that describe the learning technology used in each activity, and eventually, a statement of the results obtained. Only when the prior learning and personality traits of the incoming student are also described, will it be possible to measure the value added of the university experience and to assess whether or not the university programs at whatever cost, are creating the kind of intellectual competence they are explicitly meant to create. Such a project institutionalizes on-going classification and measurement experience in education. The conditions of this experimentation may be more of less controlled, depending upon how much information the system incorporates and in how much detail the information flows are analyzed by competent specialists. We are pointing to the direction we believe systems analysis must go if it is to be useful in cost-benefit discussions of higher education.

The fact that we have not gone this far in the present inquiry is a matter of competence and resources. It necessitates further remarks on how and to what extent the framework proposed here can be used.

In a world of uncertainty, intuition is often a better guide to behaviour than bad science.[72] According to the Oxford dictionary, intuition is a process of apprehension of the mind without reasoning.[73] Bergson is more explicit on the philosophical characteristics of intuition.[74] Intuition is offered as an alternative to positive analysis where the latter method is incapable of exposing truth, because quantitative or other scientific methods are incapable or inappropriate for informing our understanding of certain phenomenon; Cresson explains:

> "Celui qui dit: 'J'ai deux fois plus mal aux dents aujourd'hui qu'hier ne parle que par métaphore. Une douleur ne saurait être le double ou la moitié d'une autre. Elle

---

[72] We could probably prove this statement by citing the number of cases where famous intuitive decisions succeeded, while "rational" procedures could have been disasterous, but we will spare ourselves of the lengthy diversion.

[73] Concise Oxford Dictionary, 5th edition, page 639.

[74] Cresson, André, "Bergson", Collection Philosophes, Presses Universitaires de France, Paris 1964.

en est qualitativement différente: elle est 'autre' qu'elle, mais c'est tout. N'hésitons donc pas à le constater: la vie de notre moi est ce mouvement qui nous emporte de qualité en qualité et fait que nous sommes toujours nouveaux pour nous-mêmes, toujours hétérogénes à nous-mêmes, mais en même temps riches de nos expériences passées grâce auxquelles notre présent s'illumine et prend un sens. Devenir ininterrompu, devenir sans temps d'arrêt, devenir purement qualitatif, toujours souple, imprévisible et nouveau: voilà ce que l'intuition immédiate nous révèle sur nous-mêmes......

"Que la mémoire joue un rôle de première importance dans nos représentations, c'est ce que tous les philosophes ont été amenés à constater. Les sensations que nos sens nous présentent ne prennent une signification pour nous que si nos souvenirs fournissent à notre imagination de quoi les interpréter.......

Memory consists of images:

"Les images telles que Bergson les comprend, ce sont les objets eux-mêmes, qualités diverses irréductibles entre elles, qualités incapables d'une mesure mathématique exacte, qualités en perpétuel devenir, en perpétuelle et imprévisible évolution. Ces images, c'est l'être même, tel que _l'intuition_ de la durée pure nous le révèle en nous et tel que la sympathie divinatrice nous le révèle partout."[75]

Clearly, the intuitions which matter most in the instructional process can only be those of professors and students who find themselves in the appropriate existential situation, because intuition is subjective if nothing else. Thus intuition is incapable of falsifiability; therefore as a method to develop knowledge of education, it is unscientific according to Professor Popper's _criterion of demarcation_.[76] Yet Popper recognizes the legitimacy and importance of intuition. He describes it as insufficient but indispensible.[77] If we accept it as a desirable long term objective to become scientific in our use of teaching technology,[78] then it is necessary to institutionalize and systematize the necessary research, using existing and experimental university programs as a vast source of raw data to learn about learning. Gradually it will become possible to substitute scientific for intuitive information about what kinds of students, professors, techniques and methods combine in which ways and do what things to yield the most efficient learning of the kind desired. Of course the kind of learning desired will always be a matter of policy decision based on the perception of need as seen by the deciders.[79] However given the goals, the means to satisfy them could be selected on more objective grounds than we now have. Until then, financial decision making procedures which respect the intuition of those directly involved in teaching and learning will have the singular advantage of potentially maximizing university welfare in the Paretian sense. It should also yield the best available information on benefits. Insofar as financial decisions are cognizant of this information, which is really a statement of preferences informed by intuition culled from past and present experience, use of the cost accounting framework will not run the risk of inherently violating individual preferences.

---

[75] Cresson, _op. cit._, pages 32-35.

[76] _Popper_, Karl R., "Conjectures and Refutations", Harper Torchbooks, New York, 1968. Page 39.

---

[77] Popper, op. cit., page 28.

[78] Anyone who disputes this value judgement should realize at the same time that he imputes an a priori refusal of authenticity to the life of the university. If the university does not try to behave scientifically with respect to its own principal concerns (teaching for example), consistency renders it an illegitimate propagator of scientific methodology elsewhere.

[79] This begs the question of who decides. Insofar as the level of finance accorded any administrative unit is an important constraint when taken in conjunction with other constraints, it should now be apparent that unless students and professors decide on instructional matters, this aspect of academic freedom is substantially mythical.

Summary of discussion of output:

Throughout our discussion of process, we have described output as "value—added to education by the university". We have tried to indicate the problems associated with isolating this value-added, problems inherent in the difficulties of describing the initial state of inputs and the effects of process on the students' personal and intellectual development. We have also mentioned that inability to define output with some precision hinders cost-benefit analysis in education, because unless output is defined and measurable, benefit or effectiveness assessment is equally vague and rational choice between alternatives is difficult. Judy and Levine make the same point.[81]

We conclude that until output concepts in educational instruction are scientifically and operationally described, intuition will be a better guide than none to describe which processes produce which outputs.

Our present structure describes "output" in a way consistent with the way it described input. The output is simply the student taking a course. Of course, this is a proxy category. However, we are confined to describe output in this way until better definitions of output allow us to escape from this circularity.

The definition and measurement of pedagogic input, output and technically efficient production functions is essential to rational decision-making in the allocation of grants to higher education. It is also very elusive, and this may explain the attractiveness as well as the inadequacy of "administrative" models.

---

80. Judy, Richard, Systems Analysis Techniques in University Planning, OECD, DAS/EID/67.7, January 1967.

CHAPTER III

The Accounting Framework

I. Budgeting Techniques
II. Description of the Framework
III. Cost Analysis Techniques
IV. Program Planning

I. Budgeting Techniques

One function of a budget is to illustrate the sources of income and expenditure of a behavioural unit. It may be organized in different ways depending upon the purpose it is meant to serve. The main variables of budget organization are:

1) time,
2) delineation of the behavioural unit, and
3) choice of categories.

Time refers to the length of the budgeting period. Delineation of the behavioural unit refers to the selection of the unit on whose account funds are accrued and disbursed. Choice of categories refers to the selection of items accounting for the flow of funds through the behavioural unit. Budgets differ depending upon differences in these three variables.

In the university sphere we distinguish between fiduciary budgets and program budgets. The nature and problems involved in fiduciary budgeting are summarized in the following statements:

> "Conventional methods of budgeting and accounting in universities may satisfy the needs of fiduciary control, but they fail to provide administrators with information useful for making decisions. A university's current expenditures are commonly placed into resource categories such as academic

salaries, non-academic salaries, supplies, equipment, etc. Budgets and reports are drawn up for basic budgetary units (e.g., academic departments), aggregated within faculties and schools, and summarized for all parts of the university.

"University administrators at all levels, from departmental chairmen through deans to provosts and presidents, find little information in such budgets to guide them in allocating resources within their institutions. To governmental departments and ministries of education, such budgets are opaque screens revealing dim shadows of the real patterns of activities and costs within the university. Credibility of stated requirements must rest on the persuasive powers of subordinates and on the faith of superiors. One writer phrased his criticism in the following words:

> 'Conventional budgetary formats provide very little information of value for decision making. They cover short time frames, provide no clues to what is being done, point up no relations between teaching and research, provide no guides to graduate and undergraduate levels, and exhibit no information on costs except in a relatively inaccurate aggregate sense; moreover, they may contribute to obscuring rather than sharpening management decisions.' (Williams, H., Planning for Effective Resource Allocation in Universities, American Council on Education, Washington, 1966).

"For purposes of rational resource allocation in universities, the fundamental flaw of conventional financial reporting is that it is not oriented toward institutional objectives. These objectives should be formulated in such terms as the following:

1. The quality and quantity of first degree graduates in the various fields of study.

2. The quality and quantity of graduates from various advanced study programs. ..."[1]

---

[1] Judy, R.W., Simulation and Rational Resource Allocation in Universities. O.E.C.D., January, 1967.

The main purpose of program budgeting is to associate expenses and costs with specific programs. Harry Williams offers the following very useful chart which summarizes the important distinctions between fiduciary and program budgeting:

The Focus of Program and Conventional Fiduciary Budgets

Program Budgeting	Fiduciary Budgeting
Alternative ways to achieve university goals and objectives.	Sources of funds.
Major programs in teaching and research.	Constraints on receipt and expenditure of funds.
Resource requirements explicitly related to each program and sub-program.	Aggregates of expenditure on Administration Teaching and Research Maintenance Student Services.
"True" costs of major programs and program elements.	Legal and administrative accounting for funds.
Marginal and opportunity costs.	Average cost ratios.
Long time periods.	Short time periods.
Level of activities "produced".	Purely fiscal matters. [2]

---

[2] Williams, Harry, Planning for Effective Resource Allocation in Universities, Washington, D.C., American Council on Education. 1966. Pp. 15.

Program budgeting is a form of budgetary organization which facilitates the kind of analysis necessary to assess the cost implications of alternative programs and methods.

The immediate question this presentation begs is that of the definition of programs and program elements. Boxus, Jadot and Walckiers share our concern that the object of university planning in the instructional sphere should be to identify very specific educational objectives (e.g., in terms of developing competence in specific disciplines), then identify the process by which these objectives are achieved in as much detail as possible. The detail is important because each aspect of the instructional process is a matter of choice and cost that contributes to accomplishing the stated objective. The authors present a schematic representation of the form such an identification may take:

	OBJECTIF SCIENCES ECONOMIQUES		
OBJECTIFS	Enseignement des Sciences Econom.		Recherches
PROGRAMMES	1er cycle	2é cycle	3é cycle
SOUS-PROGRAMMES	Economie Générale	Economie Mathématique	
ELEMENTS DE PROGRAMME	Cours d'écon. politique	Cours de Macro-écon.	Cours de Recherche Operationelle. (3)

They comment:

> "This presentation allows analysis of resource combinations to be used for the 'production' of a certain number of diplomas at each level and in each orientation. The choice of various orientations as sub-programs is perhaps more thought-provoking than the traditional categorization by candidacies degrees, etc. This new format aids an appreciation of the complementarity of program elements. It underlines the necessity of a data-bank complete with student enrollment statistics, not only by discipline, level or orientation, but also by course."[4]

Instead of using only the course as a unit of analysis, we identify the form instruction takes by the term "Formal Instructional Unit" (FIU).

---

3. Boxus, Jadot and Walckiers, "Essaie d'application des techniques PPBS à l'Université Catholique de Louvain". Louvain, 1969.

4. *Ibid*. Our translation from the original French.

An Activity is a sub-unit comprised within an FIU. For example, if an FIU were to be a course consisting of lectures and conferences, then the lectures and conferences are activities. Thus, a course which consists of, say, two lectures and a conference, or any number of lectures and conferences, has two activities in it: lecture and conference. If the formal instructional unit is a seminar which meets regularly in the same way, then this FIU has one activity, and the FIU and the activity are the same thing.

In cases where correctors are hired for correcting examinations and term papers at a fee, the correcting of such papers are considered as a separate activity for that FIU. We do not consider such correction a separate activity when this work is done by teachers engaged in that FIU for no fee other than what they receive for their other duties to that FIU. This distinction is consistent with the frame of reference for the accounts that we describe in the Introduction, page 6, paragraph 2.

If the creation of FIUs and activities are deduced from the objectives of the participants, then the program elements represented by the FIU constitute an operational statement of the objectives. (5) (6)

When a certain number and kind of formal instructional units are combined, they become a program. We may make combinations of any sort. Some combinations will be more useful for administrative purposes, others for pedagogic purposes. For example, if the administrative unit in the institution is a department, yet a program bridges departments, it may be useful to present two accounting formats; one that will serve administrative purposes in the department, the other that will inform about costs and outputs of different programs. For example, it may be that the university finds it useful to give students of business administration ecology instruction so that future executives of detergent companies will be mindful of the broader social consequences involved in manufacturing detergents with phosphate pollutants. The Business Administration program would then

---

5. Boxus, Jadot and Walckiers, op. cit., page 34.

6. This statement is valid when the discussion is limited to form. In Chapter II we argued that form is an inadequate description of content. Boxus, Jadot and Walkiers are aware of the same problem and make similar comments on pages 36 and 37 of their study.

include courses from the natural sciences departments. Thus, the accounting framework should be designed to serve two purposes:

(1) To allow the departments to calculate their instructional budgets,

(2) To cost programs.

The accounting framework we have devised can be used both ways. It simply requires adjusting the content to suit the purpose. For example, to analyze the departmental situation of 1968-69, we present a departmental classification. To construct a hypothetical program we could use a classification that includes the activities proper to the program involved. The relationship between program and departmental budgets can be established by assigning to each department its share of cost for services rendered to any program. Thus our accounting framework kills two birds with one stone, simply by juggling categories and time periods. It is a program budgeting technique that is as flexible as is the word program.

II. Description of the Accounting Framework:

We proceed to describe how the accounting framework is built:

a) within the constraints suggested by the issues raised in Chapter II,

b) to carry out cost analysis, and

c) to fulfill the pruposes of program budgeting, or planning.

The framework will account for the following variables that we consider operational for the purpose of systems analysis.

The distinction between inputs and outputs is relative to the structure of the accounting framework. An input is an observation. An output is information that results from the arithmetic manipulation of at least two input observations. For example, if $\underline{x}$ is one input observation and $\underline{y}$ another, and the accounts define $\underline{z} = \underline{x} \cdot \underline{y}$, $\underline{z}$ is an output of the accounts.

Figure I illustrates the layout of the accounting framework. The numbers which identify each input and output above correspond to the column numbers in Figure I. Each symbol is identified in its appropriate column. The way in which outputs are calculated from the inputs is identified by the formula appropriate to each output in its respective column.

(a) Inputs:

1. Activities:

   (L) Lectures

   (A) Labs

   (C) Conferences

   (D) Discussions

   (S) Seminars

   (M) Separately financed administrative duties specific to classes.

   (E) Separately financed evaluation duties specific to classes.

An activity is broken down into sessions. Each time a student goes to the activity and does something different than he did before, we say that he attends another session. A class is any activity bringing students and teachers together. There may be many more classes than sessions, because not all students may cover the same material in the same session. This occurs when sessions are held in more than one group because of large enrolments.

2. Time:

(1) The total number of weeks over which the activity is carried in the year.

(2) The sequence of student participation in the session. (For example, whether the student attends sessions, weekly, every two weeks, monthly, etc.)

(3) The duration of each class.

(4) The number of sessions each student is expected to attend per sequence.

3. Students:

(7) The number of students enrolled in each activity.

(8-9) The number of enrollees participating in the activity at one time.

4. Staff:

(13) The identification number of the person teaching each activity.

(14) His academic rank.

(15) His gross salary excluding fringe benefits, per hour or per annum, whichever applies.

(b) Outputs:

1. Physical:

(5) The number of hours per sequence that each student attends each activity.

(6) The number of hours per annum that each student attends each activity.

(11) The number of teaching hours needed per sequence for each activity.

(12) The number of teaching hours needed per academic year for each activity.

(17) The percentage of the teacher's load spent on each activity.

2. Financial:

(18) The total cost per annum of carrying the activity.

(19) The unit cost per student per annum for each activity.

(20) The cost per hour of teaching for each activity.

(21) The cost per hour per student attending each activity.

3. Auxiliary:

(22) A weighting factor to be used for analysis of the variance in cost per staff member per hour.

We explain in detail the way in which costs are developed from the resource loading procedures established in the accounting format. We remind the reader that this is a partial technique in the sense that it only accounts for the consumption of salaries of academic staff and other teachers in instruction. It would be helpful to follow the explanation accompanied by the accounting format (Figure I).

Cost analysis and budget forecasting in the university requires that we be able to account and predict how many students enroll in the institution, and how this enrolment is distributed between activities which consume institutional resources. We may account for resource loading in different ways depending upon the purpose to be served. We envisage two ways of accounting: one by administrative unit, the other by program. The accounting by administrative unit is necessary to indicate the resources which must be placed at the disposition of the unit to serve the requirements of the various programs it services. Assuming that each discipline is administered by a department which groups the human resources relevant to that discipline, these departments will be called upon to serve programs, most of which probably bridge more than one discipline, and therefore more than one department. The departmental accounting would indicate the cost of running a discipline, while the program accounting would indicate the cost of running a program. The sum of the departmental contributions to each program must be the same as the program budget.

We now require a taxonomy of programs and activities within the programs. This taxonomy describes the categories for which we may predict enrollment. The criteria for selection of categories is as follows:

(a) They must be general enough to include program structures that vary widely in degree of rigidity, a program being more rigid the narrower the choice of activities open to the student.

(b) They must be detailed enough to predict down to the level of the FIU, because this is the prime unit in terms of which we calculate costs.[7]

(c) They must facilitate the definition of programs in a way that yields an unambiguous notion of what competence the programs impart to students, at least with respect to coverage of subject material.

We suggest that any student may demand from any one department at least one and no more than (M) the maximum load of FIUs consistent with his program. Let us assume for illustrative purposes only that this maximum is estimated at four. The range of load that a student can place on a department we denote as "r" and in our hypothetical situation, "r" varies from 1 to 4.

---

[7] Occasionally the enrolment in one activity is not the same as it is in the other activities of the same FIU. Our sample indicates that this happens infrequently enough to ignore the problem in the general definition of program enrolment.

The factor which distinguishes one program from another is the emphasis that the student places on a discipline. No matter how general an education the student may acquire, under conceivable circumstances in our system he will develop specialization in at least one discipline. He may also develop joint specialization in more than one discipline.

Thus, the initial stage of course enrolment formulation consists of classifying students by major discipline(s) (symbol "d") and by "r":

FIGURE II—GRAPHIQUE II

r	d_1	d_2	d_3	E
1	300	400	200	900
2	250	150	200	600
3	75	100	125	300
4	50	100	150	300
TOT	675	750	675	2100

Fields Champs de connaissances		
r_1d_1	r_1d_2	r_1d_3
r_2d_1	r_2d_2	r_2d_3
r_3d_1	r_3d_2	r_3d_3
r_4d_1	r_4d_2	r_4d_3

In Figure II we have classified 2100 students (E) by major disciplines d_1 to d_3 and by the number of FIUs they are expected to take in any one department in one year. Thus, r_3d_3 indicates that we expect 125 students enrolled in d_3 to take 3 FIUs in the department being accounted. The utility in dichotomising by "r" and "d" rather than by "d" alone is that the former method facilitates situating the subject-emphasis of a student's program rather exactly. We submit that this is pedagogically useful. Possibly, it may add precision to forecasting down to the departmental and course levels.

Each square linking an "r" and a "d" we call a program field, and we note these r_xd_y. The term program field is simply a convenient expression by which we refer to the distinction that is made between programs that (1) emphasize different disciplines (d), and (2) emphasize different degrees of penetration into those disciplines (r). Within each program field, there could be a free choice of FIUs available to the student. The minimum constraint of this choice is the value of "r" for the field, and the maximum constraint is the number of FIUs.

Suppose that for each program field the choice distribution appears as follows:

Field	n
r_1d_1	2
r_1d_2	4
r_1d_3	8
r_2d_1	3
r_2d_2	5
r_2d_3	4
r_3d_1	3
r_3d_2	6
r_3d_3	7
r_4d_1	4
r_4d_2	7
r_4d_3	10

For example, $n = 8$ in r_1d_3 means that the students may choose between 8 FIUs.

"n" is the number of FIUs from which each student in the respective field is free to choose. The average number of enrollees per FIU (e) from $E_{r_xd_y}$ is:

$$e = \frac{E_{r_xd_y} \cdot r}{n} \qquad (1)$$

where $E_{r_x d_y}$ is the number of enrollees in the field $r_x d_y$. In our example, from $E_{r_2 d_2}$ there are 60 enrollees in each of the 5 FIUs open to those students, assuming that students are evenly distributed over the FIUs.

To derive total enrollee load on any particular FIU, we tabulate the particular FIUs available in each field. This configuration is random, but consistent with previous information.

Table I

Field:	r_1d_1	r_1d_2	r_1d_3	r_2d_1	r_2d_2	r_2d_3	r_3d_1	r_3d_2	r_3d_3	r_4d_1	r_4d_2	r_4
FIU: 1	x	x				x						x
2			x					x				
3		x	x								x	x
4				x		x						
5	x		x					x				x
6				x				x		x	x	
7		x							x			x
8				x					x	x		
9			x			x					x	x
10		x				x				x		
11			x					x			x	x
12					x				x		x	
13			x				x	x				x
14					x		x					
15			x						x		x	x
16					x			x			x	
17			x				x			x		x
18					x				x			
19					x				x			x
20									x			
n	2	4	8	3	5	4	3	6	7	4	7	1

The total enrollee load on an FIU is the sum of the loads placed on it from each field. Thus, FIU 1 will be loaded from fields r_1d_1, r_1d_2, r_2d_3, and r_4d_3.

Let us assume that FIU 1 is a social science course and d_3 is a science discipline. Students in the field r_2d_3 take two FIUs in the science discipline. Those for whom M is greater than 2 may take, for example, FIU 1. In general, to determine the number of extra-disciplinary students loading an FIU, classify students according to field and M. In all fields where the difference between r and M is positive, call the difference D. Take formula (1) above and replace r by D. The value of n in this application becomes the number of extra-disciplinary FIUs from which the student is free to choose (n^*) in that field. The modified version of Formula (1) is:

$$e = \frac{E_{r_x d_y} \cdot D}{n^*} \qquad (2)$$

Apply formula (2) to derive the average extra-disciplinary load that the FIU may be expected to accomodate. The same behavioural factors that apply to the determination of values using formula (1) apply to that of using formula (2).

As far as our department is concerned, FIU 1 services four program fields from three major disciplines. The cost to be apportioned to the department, to the program field or to the major discipline can be calculated with the information provided in the accounting framework. The departmental cost is the total cost of the FIU. The cost to each program field is the unit cost per enrollee per FIU multiplied by the number of enrollees in each FIU relevant to the field. The unit cost per student (CU) in any program may be found by summing CU for each FIU he takes. The cost per major discipline (d) is the sum of the field costs relevant to the discipline involved: in our example, the cost of d_1 being the sum of costs incurred by fields r_1d_1, r_2d_1, r_3d_1 and r_4d_1.

The taxonomy we have developed defines how to organize student accounting.

We note certain behavioural factors which must be ascertained to accurately forecast student enrolments:

(1) The definition of disciplines and the values of "r" are a function of academic policy.

(2) The forecasting of student numbers by program field is partly a function of student preferences, which may be determined *a priori* by questionnaires; or it may be based on projection from analysis of past trends, corrected for any major change in the kinds of social and economic parameters that determined student preferences in the past. It is also partly a function of academic policy. In universities where program structures are fairly rigid, it may not be very difficult to estimate the "r" distribution of students and the value of "n" in any major discipline. In freer structures, where students have a wide latitude of relatively unconstrained choice, predictive ability will probably grow with several years of observed data. In this respect, it is useful for the university to conduct enquires which determine what motivated student course choice.[8]

---

8. The Course Evaluation Questionnaire of McGill University's Centre for Learning and Development incorporates a section on course choice motivation. The factors they include are: Repeating the course; a required course; interested in the subject; heard the course was good; catalogue description sounded good; thinking of graduate school requirement; fit nicely into my schedule; sounded like an easy course; and friends taking this course.

(3) The value of "n" is a function of academic policy, size of department and kind of professional competence available. We expect that "n" would usually be larger in large departments and smaller in small departments which do not have the resources to offer as many options.

(4) In the description of the taxonomy we assumed that in every field, students are evenly distributed over the FIUs they take. This assumption is a convenience that may not be true in every particular case. Uneven distributions could result from a variety of factors that may be explained by the course motivation questionnaire. It would be useful for purposes of enrolment forecasting to observe the occurance and extent any systematic deviations from the mean. These observations could be incorporated into the projection to refine the estimates.

(5) The particular FIUs available in each field are a function of academic policy.

Once the number of enrollees (e) for an FIU is known, the planners decide on "z" or the number that will normally participate in a session of each activity. In Table I, col. 7, indicates e = 315; col. 8, z = 315. The formula $g = e/z$ applied in col. 10 indicates that the result of the policy decision is one group. In the analysis application of the accounting framework, the value of z is simply observed *ex post* from departme[illegible]l records or by interviewing the teacher. In the planning application, _z_ is an _a priori_ academic decision.

Given the number of groups, we then derive _the number of contact hours required per sequencing period_ (Tb). The sequencing period "b" defines the sequence of student participation in the session. (e.g., whether the student attends sessions weekly, every two weeks, monthly, etc.). "b" is tabulated in col. (2) of Table I. The formulae by which we derive Tb are found in cols. (5) and (10) respectively of Figure I. They are: (a) $h = d \cdot y$

(b) $Tb = g \cdot h$ where:

"d" is the duration in hours of a session (Table I,col. 3), and "y" is the number of such sessions per sequencing period that a student in the activity is normally expected to attend (Table I, col. 4). Formula (a) thus yields the number of hours per sequencing period that each student in a group is normally expected to attend the activity. Formula (b) multiplies this number of hours by the number of groups (g), yielding the value of Tb. (Table I, col. 10).

We then transform "Tb" into an annual (academic year) requirement of contact hours for the activity. This amount depends upon two things:

(a) "s", the number of weeks in the academic year over which the activity is spread, and

(b) "b", the sequencing period.

When the number of weeks in the academic year is adjusted for the sequencing period by multiplying the factor "b" by "s", and this result is in turn multiplied by "Tb", the result is the number of required contact hours for the activity per academic year. The information concerning "s" and "b" per activity is tabulated in Figure I. columns (1) and (2) respectively. The output "Ta" is tabulated in column (12). "Pe", tabulated in column 6, is the number of contact hours per annum that the student attends the activity. It is the result of the multiplication s.b.h.[9]

From "Ta" we derive the required number of teachers to handle the load. This depends upon "x", or the total annual teaching load in contact hours for which the teacher involved in any activity will be responsible in his overall teaching commitments. Thus, when "Ta" is divided by "x" the result is a factor "Pt" (Table I, col. 17) that indicates the fraction of the teacher's total load which he expends on the activity at hand. If more than one teacher is involved in sharing the load of this activity, the value of "Pt" for each is calculated. We offer an example of this operation in the subsequent discussion.[10]

---

[9] "*Ta*" may be derived by the multiplication (*Pe*.*s*). This simplification theoretically dispenses with the need for the columns itemizing *s*, *b*, *y*, *d*, *h* and *Tb*, and lessens the amount of information that appears in the accounts. Two considerations lead us to maintain these columns anyhow. They are:
(1) They simplify data gathering procedures and may eliminate a source of inaccuracy. The reason for this is that *Pe* must be derived by the arithmetic manipulation (*s*.*b*.*h*.). Whereas data providers have *s*, *b*, and *h* information on their files, calculating *Pe* imposes an extra burden on them. We have chosen to leave that task to the computer.
(2) The information in the theoretically dispensible columns may be useful for those who wish to study the timetabling aspects of the activities. These become interesting especially with the introduction of pedagogies that depart radically from the lecture system.

From the value(s) of "Pt" we derive total salary cost of the activity, (C), by multiplying the fraction "Pt" by the salary of the teacher. Much discussion of the legitimacy of this method of calculation follows on page 151 . To determine the cost of an activity where several teachers are involved, we sum the results of this operation carried out individually for each teacher.

The information in columns 19-22 of Figure I is derived from what preceded as follows:

---

[10] See page 165.

Col. 19, unit cost per student (CU), equals C/e.

Col. 20, unit cost per contact hour (CH), equals C/Ta per teacher.

Col. 21, unit cost per hour per student (A), in the activity equals CH/z, or CU/Pe. $A = \frac{CH}{z} = \frac{CU}{Pe}$ since $\frac{CH}{z}$ and $\frac{CU}{Pe}$

both equal $\frac{C}{Pe.g.z} = \frac{C}{Pe.e} = A$.

Col. 22, the weighting factor, equals $T.z$.

The purpose of the weighting factor is to derive a weighted average number of students per contact hour per teacher, according to the formula $\sum \frac{T_i z_i}{T_e}$ where i denotes the activity, "e" the teacher, T is Ta and z is the number of students per session. We believe that this measurement yields a better picture of the relationship between student numbers and teachers than the more traditional staff/student ratio. The former ratio indicates the number of enrollees per activity for which a teacher is responsible. Unlike the staff/student ratio, it is a clearer indication of the student numbers that any one teacher must contend with in the course of his teaching duties.

These calculations may be used for comparative analysis.

Costs at various levels of aggregation are determined by aggregating C values wherever needed. The procedure we have just completed yields the cost of an activity where one teacher is involved, or the cost of that part of an activity specific to one teacher where more than one teacher is involved. The value of an FIU is determined by aggregating the costs of the constituent activities. We use the following aggregation procedures: At the level of each activity, we sum Ta to yield the sub-total of Ta for the activity, sum C to yield the sub-total of C, divide sub-total C by e to derive sub-total CU, divide sub-total C by Ta to derive sub-total CH.

At the level of the FIU, we sum the sub-totals of Ta to yield Ta total, sum the sub-totals of C to yield C total, sum sub-totals CU to yield CU total, divide C total by Ta total to derive an average CH, divide CU total by Pe total to derive average A.

The value of the departmental teaching budget, as far as this analysis goes, is determined by aggregating the cost of all FIUs it supports. Cost may be apportioned to program fields and major disciplines as described on page 132 above.

For purposes of program budgeting, the accounting format provides a convenient format for planning the future of such variables as:

(a) the number of activities in a department or a program
(b) the number of students
(c) teaching loads
(d) salaries
(e) student/staff ratios
(f) activity lengths
(g) numbers of teachers required
(i) expenditures

for each activity in the system. Different situations may be simulated, their financial implications compared, and their pedagogic desirability estimated as best we can. Choice will then be more informed as more refined ideas of relative cost can be compared to estimates of anticipated pedagogic benefits. Before discussing analysis and programing techniques and results, we discuss the theoretical implications of the accounting procedures. These have to do with defining enrolment estimating workloads, and deriving costs.

(1) Enrollment (Col. 7, symbol 'e'):

Very often, precise enrolment figures in courses are difficult to obtain. This is not so much a problem of poor book-keeping in the university, but more to do with the definition of enrolment. The most usual situation is one in which a number of students formally sign for a course in which they will be examined, or in which it is understood before hand that they will not be examined. There are unusual situations which occur as well. Sometimes students drop out of courses without informing the proper administrative channels. These cases are undetectable until it is discovered that they should have written an examination but did not.

On the other hand, some students regularly "drop-in" to courses (for which they are not enrolled) either as auditors or for credit, simply to have the benefit of instruction in particular areas that interest them in general, or for other aspects of their formal programs. This is more frequent at the graduate level where students preparing for comprehensive examinations may sit into one course or another, informally, to aid their preparation. In our accounting, we consider that what matters most is the number of students benefiting from instruction. The administrative details of their status matters less in a pedagogic sense. It is, however, administratively important to know the planned number of students involved in any one classroom situation for an assessment of staff/student ratios and for purposes of space allocation.

It may be useful to have several measures of student enrolment. Anticipated or actual average enrolment would yield the most accurate notion of the amount of space required for any class. Deriving this figure requires estimating the factors that would cause it to differ from registered enrolment. Given the fact of indivisibilities in space allocation, the divergence between average and registered student numbers probably matters less for larger undergraduate courses than for smaller more advanced courses. Cost-per-student estimates will be less affected by slight divergencies in larger than in smaller classes. Therefore, for purposes of more convenient data collection procedures, we use registered enrolments for undergraduate classes, and where possible, we obtain average attendance figures for graduate classes by asking the departmental personnel who know.

(2) Teaching loads and load apportionment ('x' and 'Pt', Cols. 15 & 17).

The measurement and accounting of teaching loads in terms of contact hours is a proxy measure of the total professorial workload. There are four reasons why we employ this proxy measure.

Firstly, the nature of the professorial instructional workload makes objective measurement difficult. Behind the contact hour lies preparatory, administrative and evaluatory inputs about which it is difficult to secure reliable information. The exception to this difficulty occurs when these "ancillary" teaching duties are paid on a piece-rate basis. For example, if the institution pays markers a rate per exam paper, tutors a rate per contact hour of teaching (where a "normal" volume of preparation is explicitly understood between the contracting parties), and administrative assistants a set fee for administering a course, then the accounting is simplified by the existence of objective criteria derived from established conventions. When a professor is paid a single salary for doing all of these things in any way he sees fit, there is no obvious criteria for attribution of cost to specific tasks because there are no established conventions.

Since we wish to account for all instructors that incur cost to the institution for instructional activity, we account for the ancillary teaching duties of preparation, administration and evaluation when they are paid apart from the normal salary of the professor. In such cases the work is usually done by teaching assistants. When these duties are performed by full-time salaried university staff who receive no supplementary remuneration for them we use the proxy measure of contact hours to account for their workloads.

The second reason why we use the proxy measure of contact hours is that the time commitment to other professorial functions is difficult to measure. Research, research supervision, general administration and public service all consume professorial time. The amounts are not determined on any *a priori* basis, and the time commitment may bear little relationship to the quality of what is produced.

An interesting discussion by Carrese and Baker[11] throws light on the nature of this problem. Their argument is that there exists inherent uncertainties in the accomplishment of research objectives that make it difficult to establish general relationships between time input and research output. The nature of these uncertainties is as follows:

(1) Not all tasks or activities needed to achieve program objectives can be determined with a high degree of confidence.

(2) Not all tasks required to achieve objectives are accomplishable, given certain magnitudes of effort, and

---

[11] Carrese, Louis M. and Baker, Carl G., "The Convergence Technique: A Method for the Planning and Programming of Research Efforts", *Management Science*, Vol. 13, no. 8.

this information often becomes apparent only when the work is undertaken.

(3) The duration of task performance is difficult to estimate generally because there are a priori variables and parameters that change from one project to another.

A third reason for using the proxy measure is that the definition of what constitutes administrative, public service and research output is difficult to establish. In our view, inadequate definitions of these outputs would limit the utility of linking them with their inputs.

A fourth factor that favours the proxy measure is the joint output problem. Richard Judy explains the nature of this problem in the following terms.[12]

> "The name of the cost-benefit game is the attribution of costs and benefits to particular alternatives or programs. Program Planning and Budgeting (PPB) establishes programs in relation to certain objectives. Costs are then attributed to programs and cost-effectiveness analysis is invited.
>
> "So long as there exists a one-to-one correspondence between a process and an objective oriented program, no serious attribution problem arises. But when two or more objectives are furthered by the same process, we have the phenomenon of joint production."

---

12. Judy, R., "Costs, Theoretical and Methodological Issues", May 1969. Mimeograph.

"Teaching and research are usually regarded as joint outputs of a university professor's activities. Public service and consulting are often added to the list of joint products. A professor working on a funded consulting project may be collaborating with a graduate student, (teaching) expanding his own knowledge (research) and accomplishing the objectives of the project's sponsor (consulting) simultaneously. Attribution of the project cost to any one of the three ends being served is arbitrary. It is like trying to attribute the grass eaten by the sheep to the mutton or the wool.

"Most attempts to allocate university costs to programs flounder on the problem of joint products. Typically an inventory is taken of faculty activities. Each faculty member is asked to distribute his effort among programs, e.g., undergraduate instruction, graduate instruction, research, administration, etc. This produces, for each faculty member, a vector of proportions indicating the share of his effort devoted to each program $A_i = (A_i1\ A_i2 \ldots A_in)$, where A_ij is the percent of the i^{th} faculty member's effort devoted to the j^{th} program. Programs costs are developed by distributing faculty salaries among costs thusly: $P_j = \sum_i A_ij S_i$

where P_j is the academic salary cost of the j^{th} program and S_i is the annual salary of the i^{th} faculty member. Other costs are allocated in rough proportion to academic salaries.

"This procedure simply ignores the problem of joint production which, in a good university, is a ubiquitous phenomenon. Difficulties of this kind can cause serious administrative confusion. An example of this is the dispute about which governmental agency, the federal National Research Council or the provincial Department of University Affairs, should pay for certain programs that have outputs of both research and instruction.

"Fortunately, the problem is not completely intractable. Suppose that an analyst knows that two outputs, x and y, are jointly produced by a process, but that he (the analyst) is interested only in increasing the output of x. Then, if he knows the value (market or otherwise determined) of y and the technology of the joint production process, he can assess the value of the by-product y associated with proposed increases in the output of x. The value of the by-product y can then be subtracted from the cost of raising the level of the process to produce x. In doing this, it is very useful to work with a quantitative model of the process."[13]

Judy's solution is theoretically sound, but it depends on the availability of a model of the technology of the joint production process. Serious problems in defining and measuring university output render the description of the process very difficult. At this stage of our enquiry we have not researched this problem.

Thus, if we say that a teacher's load is 104 hours per annum, as indicated in the example of Figure One, Col. 15, we do not mean that he only does 104 hours of work. What we are saying is that he does 104 hours of objectively measurable work. The 104 hours is a proxy measure that includes all aspects of his teaching duties. Some teachers will work more than others to produce the same amount of output thus defined, however, that is something about which it is difficult to gather objective information.

---

[13] Judy, op. cit., page 16-18.

The use of the proxy measure involves certain difficulties and limitations. Firstly, it may not be a good measure of effort.

When we apportion the contact hours involved in one activity as a percentage of total contact hours in all activities (Col. 17) and this is used to derive a value of his contribution to this activity, we are assuming that the total effort to any activity is proportionate to the number of contact hours involved. Of course this is not necessarily true, but it is all we have chosen to say objectively. This makes it very important to be careful in our comparisons of teaching loads. Different departments will have different policies regarding load level and load distribution for members of academic staff. If it appears that one member of staff has a significantly lower load than another, he may not be relatively underworked. Policy could reflect many hidden considerations which do not appear in the Tables. Some of these in relation to the staff member may be:

(1) He is new and in this department new people are less worked than more experienced people,

(2) He has substantial administrative or research or public service duties which occasion him to merit a reduced teaching load,

(3) The courses he is assigned to teach may require an unusual amount of background preparation and attention,[14]

(4) He is assigned to teaching in terms of a number of courses rather than a number of contact hours, and the courses may not be of equivalent length, or established equivalences of differing course lengths may not really be equivalent in terms of contact hours,

(5) His load may be adjusted for an unusual burden of graduate supervision.

The range of variation due to any one of these factors could be very large.

It is, therefore, apparent that before an extra-departmental level of decision making comes to conclusions on the basis of figures provided in this kind of accounting framework, they should be furnished with a descriptive profile of departmental policy in these and other matters that are deemed relevant at the departmental level. It is of course difficult to be quantitatively exact about many of these matters, but that does not make them unimportant or immaterial. They may be critical. The whole character and quality of intellectual effort in the department may hinge on such unquantifiable items as the amount of time spent supervising the work of graduate students, the amount of time devoted to research and publication, and the teaching effort expended on each course.

---

[14] This is a matter of intuitive judgement informed by experience.

A second limitation is that the use of the proxy measure does not yield an accurate reflection of absolute cost. We describe the costing procedure of teaching activity and illustrate the problems that arise on account of the proxy measure.

(3) Costing an activity: (Col. 18) 'C':

A brief glance at Figure One indicates that the cost of an activity is determined by multiplying the ratio 'Pt' (Col. 17) by the annual salary (Col. 16). Thus, referring to Table One, since the proportion of time in the illustrated activity is 25% of the whole, 25% of an annual salary of $10,000, or $2,500 becomes the cost of instruction in this activity.

The problem involved in this procedure is that of cost not reflecting actual effort devoted to teaching activity, because of the way in which we accounted for professorial activity: i.e., by contact hours expended on teaching.

We know that the same person supervises graduate students, carries on research, performs administration, and may be doing some of these things jointly. Yet because they are difficult to measure objectively, we do not count them.

The nature of the problem is that one course may be made to appear costlier than another simply because they are taught by different people who have a different profile of commitments, all covered by the same annual salary, therefore the whole of the salary should not be imputed to instruction. Ideally this is true. Difficulties of measurement, however, make adjustment procedures most difficult to implement.

For our purposes we will assume that unusually high costs of instruction (due to distortion in workload descriptions) not only describe instructional costs, but also the opportunity cost of using professorial time for other functions as well. Viewed in this light, high costs due to low workloads probably reflect the balance of teaching and research activity rather than inefficient use of teaching resources.

Despite the difficulties and limitations of the proxy measurement, we submit that the accounting technique we have chosen has advantages and utilities which recommend it until better techniques are developed and tested.

The advantage of using this accounting method is that unlike measurement based on subjective estimates of time distribution, the accuracy of which is hard to verify, it is consistent and uniform for everyone. It is, therefore, much easier to detect its distortions and limitations then other methods which are also distorted and limited. We are simply saying that we are better informed by information which is distorted in a known way than by information which is unaccountably distorted.

The information may be less useful for gaining an accurate reflection of absolute cost per activity than it is for establishing a relative cost. When the same measurement criteria are applied to all activities, the cost of one activity may be compared to that of another, even though the dollar amounts do not represent an absolute standard of truth. For example, it is legitimate to say that a $5,000 course is twice as costly as a $2,500 course according to this accounting procedure, even though neither amount is absolutely realistic.

We have advanced several reasons for the use of the proxy measure. These are (1) not all activity is easily measurable, (2) the most obvious form of activity measurement, time, may not always be a reliable indicator of the quality or quantity of what is produced, and (3) joint output defies simple cost attribution procedures.

It is beyond the scope of the present work to solve these problems, nevertheless we suggest two projects that may be tried in subsequent investigations. The first project, a sampling technique, we recommend to discover the relative time commitments that staff spend on different activities such as teaching, research, administration and public service. The second project is an attempt to define and classify research in a way that allows us to establish a relative valuation of effort between teaching and research.

We suggest that a sampling of twenty university staff members may be undertaken to discover the pattern of staff time consumption on different university activities. The sample should include persons from different institutions, of different rank and different disciplines. The information could be obtained in several ways. One approach would consist of a diary distributed to staff members, with provision for noting the amounts of time spent on the different activities that are of interest to the analysis.[15] The procedure may be repeated at different times of the year to discover which categories undergo seasonal fluctuations, and to what extent. Thus, it may be useful to distribute the diary at least three times, once each during the September-December term, the January-April term, and the April-September summer period. It should have a time span of one week; less than one week may bias the results by over-emphasizing an abnormal day, more than one week may be onerous. The technique involves two difficulties. (1) Certain activities may occur at very specific times which are not covered by the diary periods. For example, exam marking is usually more intense at the end of term, administrative matters both at the beginning and end of term. Course preparation may be intense toward the end of the summer period for some, more evenly distributed for others. The spot-check technique we have described may not include some important activities in the snapshots. (2) The record may not be a truthful reflection of what it is intended to measure. Entries may be biased by the respondant's perception of the use to which the information may be put.

---

[15] This diary is available from the O.E.C.D., Paris, Form C-2 Ceri IM 70.03.

The purpose of the second project is to assess the quality and volume of research activity per discipline, with a view to adjusting costs so that total salary is consumed by instruction and research, rather than by instruction alone. The volume of research can be counted in terms of the quantity of a variety of publications; the quality of the work may be intimated by observing where it is publishable as well as the outside reception it receives by acknowledged academicians within the discipline, or by other people in a position to assess the work from practical or theoretical points of view.

We suggest the following procedure to assess research and to divide salary between teaching and research.

Firstly, we require a taxonomy of research output per calendar year by discipline, by form of publication (e.g., journal article, book, restricted mimeo, et al), by where it is publishable, and by some approximation of cooperating factors (e.g., elaborate laboratory equipment, computers, research assitants, et. al.). These criteria seem to us to account for most of the variability that we may observe in the field of research.

Secondly, we may select a sample of academic staff which covers each discipline in the universities, such that all seven institutions in the province are represented in the sample. We may weight the representation of professors surveyed in each discipline by the quantitative importance of each staff rank over the system, choosing at least twelve staff members per discipline. The total representation of each university in the sample may be weighted according to the size of the institution, measured by the number of full-time academic staff it employs. The total size of the sample may vary between 360 and 480 professors, assuming a breakdown of disciplines refined to a minimum of thirty and a maximum of forty. This breakdown would reflect most of the disciplines available in Quebec universities.

Thirdly, we may observe by information from Chairmen's reports and by personal interview, the quantity of finished research (defined by the research taxonomy) per calendar year over a period of at least three years. We choose a minimum of three years to have sufficient data to average unusual performances. This is important in light of the Carrese-Baker argument on page 145.

Fourthly, we may compare teaching load measured in contact hours with research output for each member of the sample, and attempt to define a relationship per discipline that yields co-efficients between research and contact hours over the full range of contact hours. The relationship may be positive or negative, linear or non-linear. We may hypothesize any form of relationship and estimate the function. A priori, we expect the relationship to be negative and non-linear. We base the negativity expectation on the simple logic that each day has only twenty-four hours and the more time consumed in teaching, the less time will remain to conduct research. This expectation implies that research and teaching are substitutes rather than complements. This may not be true, and the hypothesis may be modified subject to the interview evidence.

We base the non-linearity assumption on the hypothesis that there are scale economies in teaching loads—that is, course preparation, administration and evaluation may increase less than proportionately to the number of contact hours. The validity of this assumption depends on the extent to which the courses are similar in content, as well as the number of courses subsumed under any given total of contact hours.

Fifthly, we may apply the coefficients to the teaching loads to determine the relative value of each function. For example, where no research output exists, we impute the total salary to teaching. Where the function is negative and non-linear, for each decrease in contact hours, we impute a correspondingly higher value to research, depending upon the value of the co-efficient over the relevant class of contact hours.

The procedure involves two major simplifications:
(1) we assume only two activities (teaching and research),
(2) we avoid joint output situations.
The first simplification circumvents the very substantial difficulty of defining and measuring the output of functions such as

administration, public service and thesis supervision.[16] It may be fatal in some cases where these activities consume a very high proportion of staff time. In general we expect that the simplification should not invalidate the attempt to establish a relationship between the two functions of teaching and research, thought to be the main professorial responsibilities.

The second simplification turns around the notion that contact hour teaching situations (accounted in the present model) and research are not joint activities. Admittedly, we avoid the counting of situations where joint output occurs, therefore, activity is under-estimated and costs over-estimated to the extent that joint output occurs. Nevertheless, we suggest that this project is a useful second-approximation to the costing of instructional activity because it takes much research and teaching into account.

---

16. Two problems of input-output measurement in thesis supervision are (1) The major input is student time and the major output is that of the student. The professorial contribution both in quality and quantity is difficult to measure. (2) Thesis supervision may constitute a joint output situation if the student project forms part of the professor's other professional interests.

Our discussion of these two projects leads us to the following conclusions:

(1) The estimation of the time input over various professorial activities is a major statistical project. It may encounter problems of cooperation. There may also be difficulties of securing information that is both accurate and representative of a year's activities.

(2) The relationship between time input and activity output is difficult to determine because the definition of outputs such as research, administration, public service and theses is difficult to establish. Joint output situations complicate the task of relating inputs to outputs. The relationship between time input and activity output may be difficult to generalize.

(3) Despite the difficulties we see no alternative but to attempt the projects in the future if we are to make any meaningful progress in the study of institutional productivity.

We concluded in Chapter Two that even our definition of instructional output—the production of a contact of teaching—is a second best definition because the contact hour is really an intermediate output that has an outcome, this outcome being the change in educational achievement of the student. We also conclude that change in educational achievement is due to many other factors, many of which are hard to measure. Thus, the change itself is hard to measure. Bearing the limitations in mind, we have little choice at the present but to define instructional output in terms of the intermediate output of the contact hour.

With this interpretative information in mind, we complete our discussion of the accounting framework with reference to FIU 100 in the McGill Science Department. It is an introductory course which consists of a number of component activities: lectures, conferences, lab periods, supervision and administration.

One peculiarity of this FIU is that it makes use of closed-circuit television in the lecture activity. Normally, Ta would be 138, and we could argue that it should be 138/2 or 69. This way we would assume that the professor talks to the camera once, and the film is projected to each

I. McGill Science (MGS) MGS 1

FIU-I.	1 (S)	2 (R)	3 (D)	4 (Y)	5 (H)	6 (PF)	7 (E)	8 (Z1)	9 (Z2)	10 G	11 (TH)	12 (A)	13 (L)	14 (N)	15 (X)	16 (SA)	17 (PT)	18 (C)	19 (CU)	20 (CH)	21 (AI)	22 (TIZ)
100 L	23.0	1.0	1.0	3	3.0	69.0	1246	623		2	6.0	52	0497	0002	92	12400.00	.570	7068	5.67	134.78	.22	32670
												28	0487	0001	154	16000.00	.179	2868	2.30	103.90	.17	17194
												25	0496	0002	109	12300.00	.228	2803	2.25	112.84	.18	15475
												40	1001	0001	221	17400.00	.181	3151	2.53	78.73	.13	24932
SI						69.0						145						15889	12.75	109.66	.18	
100 M	0.0	0.0	0.0	0	0.0	0.0	1246		0	0	0.0	134	DEMO	0000	1	12.82	138.000	1769	1.42	12.82		
									0	0	0.0	134	DEMO	0000	1	12.82	138.000	1769	1.42	12.82		
									0	0	0.0	134	DEMO	0000	1	12.82	138.000	1769	1.42	12.82		
ST						0.0						414						5307	4.26	12.82	R	
100 E	0.0	0.0	0.0	0	0.0	0.0	1246		0	0	0.0	140	COOH	0000	1	12.82	140.000	1795	1.44	12.82		
									0	0	0.0	140	COOH	0000	1	12.82	140.000	1795	1.44	12.82		
ST						0.0						280						3590	2.88	12.82	R	
100 S	20.0	1.0	1.0	1	1.0	20.0	1246	54		23	23.0	62	1008	POHF	62	3600.00	1.000	3600	2.89	58.06	1.08	3348
												33	0494	0001	60	20500.00	.550	11275	9.05	341.67	6.33	1782
												22	0490	0001	75	14800.00	.293	4341	3.48	197.33	3.65	1188
												14	0497	0002	92	12400.00	.152	1887	1.51	134.78	2.50	756
												24	1007	0003	93	10500.00	.258	2710	2.17	112.90	2.09	1296
												27	0494	0002	107	14000.00	.265	3706	2.97	137.25	2.54	1458
												24	0498	0002	77	12400.00	.312	3865	3.10	161.04	2.98	1296
												31	0495	0002	158	13300.00	.196	2609	2.09	84.18	1.56	1674
												16	1006	0003	55	10500.00	.291	3055	2.45	190.91	3.54	864
												8	0487	0001	154	16000.00	.052	831	.67	103.90	1.92	432
												31	0509	0003	288	11600.00	.108	1249	1.00	40.28	.75	1674
												23	1005	0003	124	10000.00	.185	1855	1.49	80.65	1.49	1242
												26	0503	0003	43	12200.00	.605	7377	5.92	283.72	5.25	1404
												11	0496	0002	109	12300.00	.101	1241	1.00	112.84	2.09	594
												18	0491	0001	241	12950.00	.075	967	.78	53.73	1.00	972
												18	0501	0003	157	11600.00	.115	1330	1.07	73.89	1.37	972
												18	0499	0003	327	11900.00	.055	655	.53	36.39	.67	972
												18	0481	0001	122	18700.00	.148	2759	2.21	153.28	2.84	972
												18	0504	0001	303	22000.00	.059	1307	1.05	72.61	1.34	972
												8	1001	0001	169	17400.00	.047	824	.66	102.96	1.91	432
												14	1010	POHF	14	3600.00	1.000	3600	2.89	257.14	4.76	756
ST						20.0						464						61042	48.99	131.56	2.45	
100 A	22.0	1.0	3.0	.1	3.0	64.0	1306		9	132	96.0	2112	DEMO	0000	1	12.82	2112.000	27076	20.73	12.82		
TOT						156.0						3415						112905	89.62	33.06	.58	

of the two groups, cutting in half the number of personal appearances of the lecturers. Nevertheless, we estimate contact hours as if there were no T.V. because lecturers claim they spend at least twice the projection time making the film. In a complete cost analysis, costs would have to be increased by the costs of television production and diffusion. This is a complex area of inquiry which we relegate to the future.

The first activity listed is 'L', lectures. The figures in the Table MGS I tell us, that with respect to this activity:

(1) It is spread over 23.0 weeks.
(2) It happens weekly.
(3) Each session lasts for one hour.
(4) Each student is supposed to go to three sessions.
(5) Each student attends for three hours per week.
(6) Each student attends for 69 hours per annum.
(7) There are 1246 students enrolled in the course.
(8) 623 students attend class at one time.
(9) Not applicable here.
(10) This results in there being 2 groups.
(11) Therefore the number of hours to be scheduled per sequencing period is 6.

(12) The number of contact hours per academic year is a total of 145[*] which is split:

(13) between four lecturers: Mr. 497 - 52 hrs
487 - 28
496 - 25
1001 - 40

(14) The lecturers are associate, full, associate, full professors, respectively.

(15) Their workloads (total) are 92, 154, 109, and 221 hours, respectively.

(16) Their salaries are 12,400, 16,000, 12,300, and 17,400 dollars per annum, respectively.

(17) They devote 57.0%, 17.9%, 22.8%, and 18.1% of their total workload to this activity, respectively.

(18) They generate costs for this activity of 7068, 2868, 2803, 3151 dollars respectively, yielding a total of 15,889.

(19) The unit cost per student is $12.75 per annum.

(20) Each of these people cost 134.78, 103.90, 112.84, and 78.73 dollars per contact hour, respectively, yielding an average of 109.66 (weighted).

(21) Each generates an average cost per student per hour of 22, 17, 18 and 13 cents, respectively.

(22) The weighting factors per staff member.

Because of the very large size of these classes and the absence of a lecturer in person, it is necessary to have supervision. Therefore, supervision appears as the next activity within this Formal Instructional Unit. All information is the same as above from columns (1) to (11) inclusively. The remainder are explained as follows:

---

[*] It should be 138. The computer program uses time distribution factors to split the total between the participating staff. In this particular activity (and in no others) rounding errors yielded an additional 7 hours!

(12) Three demonstrators are all present at each of 138 lectures.

(13) Their rank is that of demonstrator.

(14) They have no other academic description.

(15) Their pay rate is calculated on an hourly basis and their time is recorded per hour.

(16) Their pay rate per hour is $12.82.[17]

(17) They work 138 hours per annum for this course.

(18) The cost for each for this activity is 1,769 dollars per annum, yielding a total cost for supervision of 5,307 dollars.

(19) The average cost per student per annum for supervision is $4.26— much less than the cost of lecturers excluding T.V.

---

17. Demonstrators are graduate students, paid a yearly rate for a specified number of hours of service to their department. This amounts to $12.82 per contact hour and includes any supplementary time they need for corrections and administration. It may be argued that these salaries constitute student support. Nevertheless, the department bought their services at the indicated rates. Not knowing the "market price" of such services were substitutions possible or feasible, we use the actual cost incurred to the department as if it was simply paying wages for a job done.

(20) The cost per hour is approximately 13 dollars. ($12.82 rounded).

(21) Not calculated for non-academic staff because the analysis for which we use this figure concerns academic staff costs.

"100 E" is a coordination activity requiring a sum of 280 hours split between two coordinators at a total cost of $3590, yielding a cost per student of $2.88.

Within this FIU, there are also tutorials and they are designated by the identification "100 S". In this department, it is not considered pedagogically appropriate to use teaching assistants or demonstrators for tutorials. These activities are carried by members of academic staff. The information tells us that:

(1) Tutorials were held for 20.18 weeks.

(2) They happen once a week.

(3) They each last an hour.

(4) Each student is supposed to attend one session.

(5) Each student goes to one hour per week.

(6) Each student attends 20.0 hours per annum.

(7) The enrolment is 1,246 students.

(8) 54 meet at one session.

(9) Not applicable.

(10) This results in their being 23 groups.

(11) Therefore 23 hours per sequencing period (i.e. per week) are needed.

The remaining columns indicate the division of the total of 464 tutorials between members of staff, in the same way as that of lectures above. The total of 464 is generated by the formula used to calculate column 12, explained in Figure One. Looking at the totals generated by the indicated distribution of staff to teach the tutorial program in this course, we see that the total cost of the tutorial program is $61,042 , (Col. 18) and the cost per student $ 48.99 for the year. Incidentally, as one might expect, tutorials are more expensive than lectures primarily because of the smaller number of students per class, to anticipate analysis of the information.

The FIU also incorporates labs, designated in Table II by the description "100 A". Labs have the following cost-generating characteristics:

(1) They last over 22 weeks.

(2) They occur once weekly.

(3) Each session lasts for 3 hours.

(4) Each student is expected to attend one session.

(5) Each student attends three hours of lab per week.

(6) Each student attends 66 hours of lab per annum.

(7) 1,306 students participate in the lab.[18]

(8) Not applicable.

(9) The student/demonstrator ratio is 41:1.[19]

(10) This generates 32 groups.

(11) 24 sessions per week are required.

(12) 2112 demonstrator hours are required per annum.

(13) Demonstrators are used to teach this activity.

(14) They have no other rank description.

(15) They are paid hourly.

(16) They get $12.82 per hour.

(17) They work a total of 2112 hours per annum in this activity.

(18) The total cost is $27 076.

(19) The cost per student is $20.73.

---

[18] Students not enrolled in this course attended the lab.

[19] This ratio is specified when the department gives a student/demonstrator ratio rather than a number of demonstrators present at a session. In this case the information is provided accordingly, though 164 attended labs at a time and 4 demonstrators attended each class of 164.

Adding all the sub-totals of column (18) yields a total cost of $112,905 for this FIU. The cost per student (Col. 19) is $89.62. The average cost per hour is $33.06. The lower hourly cost of demonstrators brought it down from the much higher values for academic staff. We can assert with some confidence that this is the most complicated traditional course structure we accounted with this framework. It is a large undertaking encompassing a broad variety of activities. There are other services related to this FIU, which we exclude because they do not fall within the terms of reference of this study: television facilities, technical support staff, laboratory facilities, equipment, supplies, and space. We have been able to assemble all the basic instructional information regarding scheduling and teacher arrangements in a synthetic taxonomy that will permit comparison with other courses tabulated according to the same accounting rules in the same format.

The purpose of the analysis is to find out what the absolute and relative cost differences are, then to explain them. The explanation will not be the last word on the matter because we analyze only four departments at one point of time. Whatever preliminary hypotheses emerge to explain the structure of cost differences require reexamination using other departments. Several years of data may be assembled to examine structural change over time. Our analysis is cross-sectional.

It is devoid of ideological preconceptions. We make no value judgements to the effect that less expensive structures are better or worse than more expensive structures, nor do we seek to imply that all structures should be homogenized to a common level of cost. Judgements of this kind require a trustworthy assessment of pedagogic objectives and benefits at differents levels of cost. In Chapter II we explored the reasons for which we are not in a position to make such statements at this time. Furthermore, without an inventory of the kind, scope and depth of other academic activities in the departments, we cannot judge the extent to which human capital is used inefficiently in teaching. In this case, the efficiency

III. COST ANALYSIS:

We apply the accounting framework to explain the development of instructional costs for 1968-69 between four departments in two universities—McGill University and the Université de Montréal. We have chosen one science and one social science department of the same discipline from each university. The department names remain anonymous because the salary data must remain impersonal. We develop the discussion in the following order:

(A) Purpose of the analysis,
(B) Criteria of data selection and method of collection,
(C) Data characteristics,
(D) Method of analysis,
(E) Interpretation of results, and
(F) Preliminary hypotheses.

(A) Purpose of the Analysis:

We begin with the assumption that unit cost per student per hour per course ("A") differs considerably from one university to another, one department to another, one level[1] to another, and even one course to another.

---

20. By "level" we mean the degree of advancement of the course as indicated by its code in university catalogues—e.g. "200 level" courses are more advanced than "100 level" courses. This may not be true all the time, but we believe it is the most reliable distinction short of extensively investigating the characteristics of each course.

of the instructional apparatus depends not only upon instruction, but also upon how it relates to other activities. We cannot relate instruction to other activities unless we have a valid framework of categorization and measurement for them. These we do not have. This analysis situates relative cost differences and explains them. We do not relate them to any notion of efficiency.

(B) Criteria of Data Selection and Method of Collection:

The criteria of data selection is that all information should be factual and verifiable. Therefore, we included all scheduled and produced "regular"[21] teaching activity at the graduate and undergraduate levels for which the contact hours and persons involved are known and recorded in departmental records. We secured the salary data from the salary inventory of the Conference of Rectors and Principals for academic staff, and from departmental records for teaching assistants and demonstrators. In few cases some information did not appear

---

21. "Regular" means instruction given morning and afternoon of the fall and winter terms for which the student may earn credit towards a degree.

in departmental records. For these, the departmental administrative assistants consulted the staff member in charge of the activity to provide it.

We collected the data by personally interviewing the administrative assistants of the four departments. While the process was time consuming[22] we preferred it to mailed questionnaires for the following reasons: firstly, departments receive requests for data from many sources and the structure of our experiment required 100% response from the four groups.

Secondly, the requirements of this experiment were somewhat more detailed and demanding than is often the case in such questionnaires. We wished to personally insure that response was accurate. We believed that a structured and well-defined questionnaire for future use could emerge by personally experiencing some of the difficulties that initial respondants may encounter in meeting our data requirements.

Thirdly, we benefited from discussion with the administrative assistants of the departments. We learned

---

22. It required from two to three half-days of contact with the assistants to secure complete information for one department.

of situations particular to each that assisted us in generalizing the accounting framework to incorporate the particularities of all. With the experience we have gained from these interviews we believe that future data collection may be done by mailed questionnaire, however, the questionnaire administrators should be prepared for some personal contact with respondants who may have special problems.

(C) Data Characteristics:

In this section we define what the input figures mean, what they include and what they do not include. We discuss them in order of their appearance in the accounts, wherever special explanations are necessary.

(1) "s" (duration of activity in weeks): We standardized the academic year into two terms of thirteen weeks each. Although official term lengths vary by one or two weeks from one place to another, we discovered that on the whole, teaching of the kind we measure normally occurs for either thirteen or twenty-six weeks. Departures from these norms appear in the accounts wherever they occur.

(2) "d" (the duration of each lesson): In reality, a university hour is almost always fifty minutes long. Since we measure no activity in terms of minutes, for convenience we call the fifty minute hour "one hour".

(3) "y" (the number of lessons the student attends): Irrespective of whether or not the student actually goes to class, this figure measures the number of separate lessons per time period (b) in the activity that are scheduled for the student should he wish to attend. This figure does not refer to extra classes of the same session that are required on account of their being an excessive number of students to teach in one group. (See page 122, para. 2).

(4) "e" (enrolment): The enrolment figures we use are those in departmental records as they stood in May 1969. Departmental records include students who have enrolled in the course and were still registered at the time of inquiry. We departed from this procedure in some graduate courses where official enrolment is less important than usual attendance. Where administrative assistants or professors knew of such cases, we use estimates of usual attendance. We justify these procedures on the following

grounds: firstly, no attendance is taken in most courses. This makes it almost impossible to secure usual attendance figures for all courses. Secondly, in some graduate classes where numbers are small and instruction personal enough, we assumed that the professor knew how many students usually attended class. Thirdly, we prefer usual attendance in these cases because we feared considerable under-estimates of students benefitting from instruction were official figures used.

(5) "z" (group size): Our figure is an average over all of the groups in the activity being taught by professors on the one hand, or student teachers on the other. For example, if a class of 500 were split into two groups, one of 300 students, the other of 200, for the sake of simplicity we use an average group size of 250.

(6) "x" (total teaching load per staff member): We secure this figure by summing the teacher's contact hour commitment in each activity over the academic year. Where teachers are paid at an hourly-quoted rate, the value of "x" is always equal to 1 (one). This procedure renders

"Pt" equal to "Ta". When "Pt" is multiplied by the hourly salary, the result is total cost (C).

(7) "SA" (salary): There are several methods of salary quotation. For full-time staff, the salary figure we use comes from the inventory of the Conference of Rectors and Principals of Quebec Universities.[23] Since the inventory does not include fringe benefits, neither do our figures. The salary figure is gross pay per calendar year of a theoretical eleven working months and one month holiday, before tax and before contributions of either the university or the teacher to any fringe benefit plans.

For part-time academic staff[24] we use two methods

---

23. This is the most complete and accurate inventory in the Province of Quebec. It was compiled for purposes of salary analysis and policy, of which "Etudes et propositions en vue de la mise en place d'une échelle normée de traitement pour les professeurs des universités du Québec" (by J. Bordeleau, A.P. Contandriopoulos and N. Hung) is available.

24. Teachers may be part-time under the following circumstances: (i) they may be part-time to the university as a whole, or (ii) their contribution to the department being accounted may be a part of their more basic commitments to other disciplines in the university, and the department being accounted contribures a sum either toward or over and above their salaries for their contribution to this department.

of quotation, depending upon the status of the individual. If the teacher is paid a lump sum for his contribution to the department per academic year, we quote this lump sum, before tax and before fringe benefits. If the teacher is paid an hourly rate, we quote the hourly rate before tax. It is easy to identify in the accounts whether a salary is a lump sum or an hourly rate. In the case of the latter, the corresponding value of "x" is always equal to one.

Student instructors (tutors, demonstrators, and correctors) are paid in many different ways both between departments and within departments. To simplify the accounting, we convert all payment practices into their corresponding hourly rates. We describe the procedures for each department.

(a) McGill Science: In this department, students were paid a fixed sum per academic year for a demonstratorship of a stated number of hours per week. The largest was \$2500.00 for 7½ hours per week. This time was spent in contact hours with students, although the department expects the demonstrators to correct lab reports as well. The department claims that this duty consumes little time. Using the standard base of a twenty-six week academic year, the hourly rate for this level of staff is \$12.82.[25] All other demonstratorships in this department were paid the same hourly rate, the absolute values being \$2000.00, \$1500.00, and \$1000.00 for 6, 4½ and 3 hours of work per week, respectively.

(b) Université de Montréal Science: In this department the rate of pay depended upon the kind of duty and level of course to which it applied. The rates for demonstrators, per level, were as follows:

At the "100" and "200" course levels, demonstrators were paid \$650.00 for 3 contact hours of work per week. Using the base of 26 weeks per academic year, the hourly rate was \$8.33. For the same workloads, at the "300" and "400" levels, the basic pay was \$750.00 and \$850.00, yielding \$9.62 and \$10.26 per hour respectively.[26]

---

25. 2500/7½ x 26.

26. We note that the workloads defined in terms of contact hours may mean different things between the two departments. In McGill the department considered non-contact-hour work to be minimal. At the Université de Montréal, the department considered non-contact-hour work to consume a theoretical 50% of contact-hour work, although it did not remunerate this effort over and above the stated rates for 3 contact hours. We have no way of knowing whether or not student instructors actually spent an additional 50% of their contact-hour workload on other duties. Our comparative wage rate in terms of contact hours is a proxy measure of the hourly cost of all effort that may be expended by student instructors.

All correctors at any level are paid $6.00 per hour. Correctors are persons who correct examination scripts and other work, except lab reports. Tutors were paid $8.00 per hour and they did not correct students' work unless they were paid extra at the corrector's rate for any correction they did.

(c) McGill University Social Science: This department defined a "wage unit" in terms of the standard duties associated with an introductory course. The duties consisted of four contact hours per week, 1½ office hours per week, some help in exam preparation, most of the work in grading and posting examination results, appropriate preparation for tutorials, and some administrative overhead. The value of this wage unit was $2500.00, with the exception of one course for which it was $2700.00. Since contact hours are the only reliable estimate of workloads we could secure from the department, we derived the rate of pay per contact hour on the base of the twenty-six week academic year at $24.04 for the $2500.00 wage unit and $25.96 for the $2700.00 wage unit.[27]

---

[27] $2500/4 hrs. x 26 weeks; $2700/ 4 hrs. x 26 weeks. The relatively high rate in this department is the result of using contact hours as a proxy measure for all associated duties.

(d) Université de Montréal Social Science: This department paid $5.00 per contact hour for tutors and $3.50 per hour for correctors , unless otherwise specified in the accounts for several exceptional cases where higher rates applied. In these cases, either the department considered the workload to be particularly heavy, or the pay rate depended partly on scholarship arrangements under the "Accord France-Québec".

Using input values defined in the ways described above, we derive the output values of the accounting framework and analyze them by methods we presently describe.

(D) Method of Analysis:

We analyze the data in three successive steps. The first step consists of choosing the variables of interest to the analysis; the second, aggregating the data on the chosen variables into informative categories; and the third, comparing the aggregated values and their components to explain relative variation.

Since we wish to explain variation in relative costs and their contributing factors by FIU level and by department, we aggregate the data by FIU level within each department, and by department. We explain our selection of variables for aggregation and analysis.

I. SELECTION:

The initial unit of comparison is unit cost per student per hour per FIU,(A). This unit of comparison is useful because it informs on relative costs that are not simply the result of there being more or less students taught over more or less hours. (We shall analyze the influence of student numbers and hours of instruction in consideration of total cost, as well.)

Assume we are comparing two groups, (1) and (2). We know that $A = CU/Pe$, or $A = C/Pe.e$. If A_1 is relatively higher (lower) than A_2, then (CU/Pe), is relatively higher (lower) for Group (1) than for Group (2). Given the absolute values of the numerator (CU) and the denominator (Pe) for each of Group (1) and Group (2), we may examine in what ways the level of $(CU/Pe)_1$ varies relative to that of $(CU/Pe)_2$. For example, if $(CU/Pe)_1 > (CU/Pe)_2$, $CU_1/CU_2 > Pe_1/Pe_2$, and $Pe_1 = Pe_2$ then the whole difference between A_1 and A_2 depends upon CU.

While Pe is defined by the values of s, b, and h, the value of CU depends upon C/e. If the comparison of CU_1 to CU_2 shows that CU_1 is greater (less) than CU_2, then $(C/e)_1$ is greater (less) than $(C/e)_2$. Given the absolute values of the numerator (C) and the denominator (e) for each of the two groups, we may examine how the level of $(C/e)_1$ varies relative to that of $(C/e)_2$.

While e is a variable with no other composite in the accounting framework, the value of C depends upon the relationship $C = Pt \cdot SA$. Thus, if C_1 is greater (less) than C_2 , $(Pt \cdot SA)_1$ is greater (less) than $(Pt \cdot SA)_2$. Given the absolute values of SA and those determining Pt (i.e. Ta/x) for each of the two groups, we may examine in what ways the level of C_1 varies relative to that of C_2. For example, if $(Pt \times SA)_1$ is greater than $(Pt \times SA)_2$, and $\frac{Ta}{x}_1 / \frac{Ta}{x}_2$ is proportionately greater than SA_1/SA_2, then we know that C_1 is higher than C_2 because Ta/x (i.e. the share of staff time spent on FIUs in that group relative to total teaching load of that staff) is higher relative to SA in Group (1) than it is in Group (2).

While SA is a variable with no other composite in the accounting framework, the value of Pt depends upon the relationship $Pt = Ta/x$. Thus, if Pt_1 is greater (less) than Pt_2 , $(Ta/x)_1$ is greater (less) than $(Ta/x)_2$. Given the absolute values of the numerator (Ta) and the denominator (x), we may examine in what ways the level of $(Ta/x)_1$ varies relative to that of $(Ta/x)_2$. For example, if $(Ta/x)_1$ is greater than $(Ta/x)_2$, and Ta_1/Ta_2 is greater than x_1/x_2 , we know that teaching in Group (1) relative to teaching in Group (2) consumed a relatively greater number of hours relative to total teaching loads of that staff in Group (1) than in Group (2).

While "x" is a variable with no other composite, the value of "Ta" depends upon the relationship $Ta = (s \cdot b \cdot Tb$.) The values of $(s \cdot b)$ are already accounted in "Pe" . The value of "Tb" alone is of no interest because it only differs from "Ta" by the factor $(s \cdot b)$. The value of "Tb" depends upon the relationship $Tb = g \cdot h$. While the value of "h" is already accounted in "Pe" , "Ta" will be greater (less) the greater (less) the value of "g". However, "g" is a composite, the value of which depends upon the relationship $g = e/z$. Thus, if g_1 is greater (less) than g_2 , then $(e/z)_1$ is greater (less) than $(e/z)_2$. Given the absolute values of the numerator (e) and the denominator (z) for each of the two groups, we may examine how the level of $(e/z)_1$

varies relative to that of $(\underline{e}/\underline{z})_2$. For example if $g_1 > g_2$, or $(\underline{e}/\underline{z})_1$ is greater than $(\underline{e}/\underline{z})_2$, and $\underline{e}_1/\underline{e}_2$ is proportionately greater than $\underline{z}_1/\underline{z}_2$, but $\underline{z}_1 > \underline{z}_2$, then we know that Group (1) has comparatively larger enrolments than Group (2), but it also has comparatively larger class sizes, however, its class size relative to its enrolment is such that it still has more groups than Group (2).

Starting from "$\underline{A}$" and ending at "$\underline{z}$" (an alphabetic co-incidence) we have explored a chain of relationships that explain ($\underline{A}$) unit cost per student per hour, ($\underline{CU}$) unit cost per student, and ($\underline{C}$) total cost.

The variables of interest in the analysis are therefore: $\underline{A}$, $\underline{CU}$, $\underline{Pe}$, $\underline{C}$, $\underline{e}$, $\underline{Pt}$, $\underline{SA}$, $\underline{Ta}$, $\underline{x}$, $\underline{g}$, and $\underline{z}$. We also include $\underline{CH}$, to compare the average hourly values of human capital used by level and by department.

II. AGGREGATION:

To aggregate the data by level and by department requires that we compute averages for each variable. For each variable, we state the averaging formula, and explain it. The symbols are the same as those in the accounts, with the following additions:

$\bar{}$ = average (mean)
$*$ = weighted
j = FIU
i = activity
p = professor
o = other instructors (demonstrators, tutors, and correctors)
n = number of FIUs by level or by department.

(a) A:

$$\bar{A}_n^* = \frac{\sum_{j=1}^{n} A_j (Pe_j \cdot \bar{e}_j)}{\sum (Pe_j \cdot \bar{e}_j)} \qquad \bar{e}_j = \frac{\sum e_i}{i}$$

This formula yields a weighted average value of "A" per FIU by level and by department. We weight "A" by "Pe" and "e" at the level of each FIU so that FIUs which have very few students or very few hours will not count with the same weight as those which have many students or many hours. We believe that this weighted average yields a more representative value than a simple average "A" , because "A" is a measure "per student per hour".

At the level of the FIU it is sometimes necessary to use an average enrolment figure rather than a single one because a number of FIUs are composed of different activities, some of which have different enrolments. Wherever this occurs, rather than using a single enrolment figure, we use an average enrolment over the number of activities in the FIU.

(b) CU:

$$\bar{CU}^*_n = \frac{\sum_{j=1}^{n} C_j}{\sum \bar{e}_j}$$

The formula yields a weighted average value of unit cost per student (CU) per FIU by level and by department. We use a weighted average CU rather than a simple average, so that FIUs which have very few students will not count with the same weight as those which have many students. Again, we believe that the weighted average is more representative than a simple average, because CU is a "per student" measure.

(c) Pe:

$$\bar{Pe}^{*}_{n} = \frac{\sum_{j=1}^{n}(Pe_j \cdot \bar{e}_j)}{\sum \bar{e}_j}$$

The formula yields a weighted average value of "Pe" per student per FIU by level and by department. We use a weighted average "Pe" rather than a simple average so that FIUs which have very few students will not count with the same weight as those which have many students. We believe that the weighted average is more representative than the simple average because "Pe" is a "per student" measure.

(d) C:

$$\bar{C}_{n} = \frac{\sum_{j=1}^{n} C_j}{n}$$

The formula yields a simple average of total cost per FIU by level and by department.

(e) e:

$$\bar{e}_n = \frac{\sum_{j=1}^{n} \bar{e}_j}{n}$$

The formula yields a simple average enrolment per FIU by level and by department. We use the average enrolment per FIU for FIUs which have activities of differing enrolment.

(f) Pt:

$$\bar{P}_{t_n} = \frac{\sum_{j=1}^{n} \bar{Pt}_j^{*}}{n} \; ; \quad \bar{Pt}_j^{*} = \frac{\Sigma(Pt_j^{p} \cdot Ta_j^{p})}{\Sigma Ta_j^{p}}$$

The formula yields a simple average value of "Pt" per FIU by level and department. Since Pt differs from Ta for professors but not for student or hourly paid instructors, we calculate Pt for full-time teachers only. It often happens that more than one professor teaches the same FIU. To derive an average Pt for the FIU, we take a weighted average Pt for all professors within the FIU. We weight Pt for each professor by the corresponding Ta he contributes to the FIU. In this way, professors who contribute very few hours to the FIU will not receive the same weight as those who contribute much more. In this way we derive a more representative average Pt per FIU by level and by department for the professors who contribute time to those FIUs.

(g) SA:

$$\overline{SA}_n^{P,O} = \frac{\sum_{j=1}^{n} \overline{SA}_j^{*\,P,O}}{n} \quad ; \qquad \overline{SA}_j^{*} = \frac{\sum\left(SA_j^{P,O} \cdot Ta_j^{P,O}\right)}{\sum Ta_j^{P,O}}$$

The formula yields simple average salaries per FIU by level and by department. We compute two series of averages, one for full-time staff, the other for part-time staff and student instructors. For each series, we weight SA by the Ta of each staff member in the FIU. Again, it often happens that more than one professor, or instructor, teaches the same FIU. To derive an average salary level for the FIU for each of the two categories of human capital, we take a weighted average SA for each. We weight salary for each staff member by the corresponding Ta he contributes to the FIU. In this way, people who contribute very few hours to the FIU will not receive the same weight as those who contribute much more.

(h) Ta:

$$\overline{Ta}_n^{p,o} = \frac{\sum_{j=1}^{n} Ta_j^{p,o}}{n}$$

The formula yields simple average hours of teaching per FIU by level and by department. We compute two series of averages, one for full-time staff, the other for part-time staff and student instructors. We believe that the distinction would be useful for purposes of estimating relative employment of these different kinds of human capital.

(i) x:

$$\bar{x}_n = \frac{\sum_{j=1}^{n} \bar{x}_j^*}{n} \quad ; \quad \bar{x}_j^* = \frac{\sum (x_j^p \cdot Ta_j^p)}{\sum Ta_j^p}$$

The formula yields a simple average workload of staff per FIU by level and by department. We compute one series for professors only, because in all other cases x assumes the value of one. In all FIUs where more than one professor participates, it is necessary to derive an average x for the FIU. We take a weighted average, the weight being the Ta corresponding to each staff member entering the average. In this way, people who contribute very few hours to the FIU will not receive the same weight as those who contribute much more.

(j) g: $$\bar{g}_n^{p,o} = \frac{\sum_{j=1}^{n} g_j^{p,o}}{n}$$

The formula yields a simple average number of groups per FIU by level and by department. We compute it in two series: one for professors, the other for part-time staff and student instructors. This breakdown allows us to examine the variation of group structures between professors and other kinds of staff.

(k) z:

$$\bar{z}_n^{p,0} = \frac{\sum_{j=1}^{n} \bar{z}_j^{p,0}}{n} \quad ; \quad \bar{z}_j^{p,0} = \frac{\sum z_i^{p,0}}{i}$$

The formula yields a simple average group size per FIU by level and by department. We compute two series, one for professors, the other for part-time staff and student instructors. The distinction allows us to examine variance in group sizes between the two categories of staff. Since group sizes may vary from one activity to another within the FIU; to derive an average group size for the FIU as a whole, for each of the two categories of staff, we take the simple average group size per activity as representative of group size for the FIU.

(l) CH:

$$\overline{CH}_n^{p,0} = \frac{\sum_{j=1}^{n} \overline{CH}_j^{*\,p,0}}{n} \quad ; \quad \overline{CH}_j^{p,0} = \frac{\sum \left(CH_j^{p,0} \cdot Ta_j^{p,0}\right)}{\sum Ta_j^{p,0}}$$

The formula yields a simple average cost per hour per FIU by level and by department. We compute two series, one for professors, one for part-time staff and student instructors. The distinction allows us to examine average differences in CH between the two categories of staff. In all FIUs where more than one staff member participates, it is necessary to derive an average for the FIU. We take a weighted average, the weight being the Ta coresponding to each staff member entering the average. In this way, staff who contribute very few hours to the FIU will not receive the same weight as those who contribute much more.

In sum:

For each of the four departments and at each FIU level within each department, we shall have average values per FIU of the variables A, CU, Pe, C, e, Pt, SA, Ta, x, g, z, and CH. For the variables Pt, SA, Ta, x, g, z, and CH, we distinguish between professors on the one hand, and part-time instructors and student instructors on the other hand.

III. COMPARISON:

The third stage of the analysis consists of comparing these averages to draw inferences about comparative costs and their components. We construct three tables to facilitate the comparisons. The first table is a statement of the absolute values of the averages per FIU, by level and by department for each variable.

The second and third tables provide the same information, but in index number form to permit comparison of variance between variables that have different unit properties. The first of these index number tables facilitates comparison of change in the value of each variable from one FIU level to another within each department. In each department, the "100" level FIUs assume the base value of 100, and the indices for each subsequent level indicate the value of that level's variables relative to the base. In Figure III "Illustration of Index Number Comparisons", we show the form of comparison in Part A. For v_2 (i.e. variable 2), level 400 FIUs have a value of 130 with respect to level 100 FIUs.

FIGURE III—GRAPHIQUE III

ILLUSTRATION OF INDEX NUMBER COMPARISONS
EXAMPLES DES COMPARAISONS DES INDICES DE COUTS

A. Intra-departmental; inter-level:
Coûts relatifs par niveau dans un département:

Department "X":
Département "X":

	v_1	v_2	v_n
Grand Mean/Moyenne générale	130	105	
Level/Niveau 100	100	100	100
200	110	105	
300	118	92	
400	124	130	
500	130	101	
600	145	97	

B. Inter-departmental:
Coûts relatifs par niveau entre départements:

Department "X":
Département "X":

	v_1	v_2	v_n
Grand Mean/Moyenne générale	100	100	100
Level/Niveau 100	100	100	100
200	100	100	100
300	100	100	100
400	100	100	100
500	100	100	100
600	100	100	100

Department "Y":
Département "Y":

	v_1	v_2	v_n
Grand Mean/Moyenne générale	105	110	115
Level/Niveau 100	110	113	118
200	99	107	109
300	122	114	118
400	133	94	87
500	141	118	131
600	145	122	127

The second index number table facilitates comparison of the change in value of variables from one department to another for the department as a whole, and at each FIU level. The McGill Science Department turned out to be the cheapest operation in terms of $\bar{A}_n^*$. Therefore, we use McGill Science as the base value of 100, for the department as a whole and for each level within it. The indices for each subsequent level and department indicate the value of that department's or that level's variables with respect to the McGill Science base. In Figure III, Part B, we show the form of comparison. For v_2 , the grand mean of Department Y is 110 with respect to the grand mean of Department X; level 200 FIUs in Department Y have a value of 107 with respect to level 200 FIUs in Department X.

From the identities of the accounting framework, ceteris paribus, we expect A, CU and C to relate positively with Pt, SA, Ta, g and CH, and negatively with Pe, e, x and z, between levels and between departments.

We turn to an examination of the aggregated data to see what kinds of relationships emerge and what orders of magnitude there may exist between them.

McGill Science - Average Values of Twelve Variables by FIU Level

Table II - 1

UN.#.1 SCIENC	FIU	A	PE	CU	E	C	SA	PT	X	TA	CH	G	Z
NIV P 100	3	.61	152.58	93.24	484.67	45190.8[illegible]	10133.[illegible]7	.36	149.34	245.59	41.76	[illegible].07	42.63
AUTRES							9.55			1243.33	3.95	13.33	49.33
NIV P 200	7	.75	135.46	79.57	175.57	13370.24	11549.00	.33	154.17	87.29	3[illegible].32	1.57	148.24
AUTRES							7.33			504.57	7.33	5.07	13.41
NIV P 300	11	1.24	36.38	81.47	34.70	6900.53	12469.19	.24	156.09	62.64	87.63	4.49	74.92
AUTRES							4.66			65.10	4.05	.22	6.19
NIV P 400	19	5.53	36.38	199.55	19.71	3933.16	12956.29	.26	155.78	32.73	112.[illegible]7	4.42	19.59
AUTRES							2.02			43.11	2.[illegible]	[illegible]	.93
NIV P 600	15	5.38	63.14	319.23	21.56	6483.44	14517.79	.30	187.50	63.94	1[illegible]	[illegible].13	21.5[illegible]
AUTRES							3.[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
DEPT P	55	1.15	133.43	114.01	77.45	8423.85	12934.43	.28	164.36	73.52	93.37	1.50	9[illegible].47
AUTRES							2.98			159.21	2.95	2.[illegible]4	3.50

This information applies to all pages of this table, as well as Tables III and IV:

Code

Symbol	Meaning
NIV	FIU level
P	Full-time professorial staff
AUTRES	DEMO, TUTR, CORR, PTTM (hourly)

NOTE:

The values are stated for professorial or other staff as follows:

Variables	Interpretation
A, Pe, CU, E, C	Combined for both categories of staff
SA	Yearly for professors, hourly for others
Pt, x	For professors only
Ta, CH, g, z	Separately for professors and for other staff

Montreal Science - Average Values of Twelve Variables by PIU Level

Table II - 2

UN.=.2 SCIENC	FIU	A	PE	CU	E	C	SA	PT	X	TA	CH	G	?
NIV P 100 AUTRES	3	.51	148.86	71.38	135.67	13032.15	8909.95 4.21	.55	247.33	[illegible] 732.15	39.53 [illegible]	[illegible]	125.53 38.4
NIV P 200 AUTRES	4	.67	103.57	65.49	146.03	9170.59	11917.49 6.63	.24	22 .39	211.31 432.13	53.75 [illegible]	[illegible]	125.[illegible] 29.3[illegible]
NIV P 300 AUTRES	18	2.57	69.53	169.75	44.79	7601.17	13375.18 7.29	.31	213.77	76.47 114.17	62.54 7.29	[illegible]	[illegible]
NIV P 400 AUTRES	15	6.64	56.37	354.05	19.43	5840.44	14094.80 3.82	.21	223.07	97.91 74.47	71.69 3.42	[illegible]	15.3[illegible] 2.67
NIV P 500 AUTRES	16	10.69	29.77	317.31	6.69	2119.94	15620.00 [illegible]	.12	214.43	27.34 [illegible]	74.09 [illegible]	[illegible]	[illegible]
DEBT P AUTRES	62	1.92	103.39	126.43	52.49	6656.82	13593.33 4.55	.26	217.13	43.51 155.34	75.06 4.35	1.61 [illegible]	44.4[illegible] 10.73

McGill Social Science - Average Values of Twelve Variables by FIU Level

Table II - 3

UN.=.15C. SOC	FIU	A	PE	CU	E	C	SA	PT	X	TA	CH	G	T
NIV P 100	3	.57	82.71	45.94	198.[illegible]	912[illegible].[illegible]7	5346.67	.32	69.33	43.33	51.[illegible]	[illegible]	[illegible]
AUTRES							21.76			292.67	21.76	[illegible]	39.[illegible]
NIV P 200	3	.9[illegible]	86.10	64.27	248.[illegible]	15938.55	15966.67	.54	126.67	43.[illegible]	13[illegible].3	[illegible]	[illegible]4.67
AUTRES							15.50			224.67	15.5	[illegible]	[illegible].07
NIV P 300	14	1.84	81.87	153.57	38.61	5929.49	12141.67	.43	14[illegible].93	63.56	90.19	[illegible]	38.61
AUTRES							4.31			23.47	8.[illegible]1	[illegible]	5.5[illegible]
NIV P 400	11	4.42	75.02	361.77	17.45	6314.55	8794.79	.63	132.23	70.91	73.79	.9[illegible]	16.[illegible]
AUTRES							.55			4.04	21.33	[illegible]	1[illegible]
NIV P 600	19	7.67	46.56	358.07	11.20	[illegible]013.41	13195.33	.27	139.75	41.5[illegible]	93.35	[illegible]	[illegible].2
AUTRES							[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
NIV P 700	8	14.26	28.91	412.38	8.38	3453.7[illegible]	12935.42	.23	129.43	34.[illegible]3	1[illegible]6.[illegible]6	[illegible]	8.34
AUTRES							0.00			[illegible]	[illegible]	[illegible]	[illegible]
DEPT P	53	1.71	77.47	132.68	45.09	6320.73	11616.38	.41	126.11	56.45	83.15	[illegible]	[illegible]8.52
AUTRES							9.96			39.22	3.3[illegible]	1.32	6.23

Montreal Social Science - Average Values of Twelve Variables by FIU Level

Table II - 4

UN.=.2 SC. SOC	FIU	A	PE	CU	E	C	SA	PT	X	TA	CH	G	Z
NIV P 100	1	.91	63.04	53.01	133.31	7066.74	10539.60	.33	131.92	72.30	75.42	[illegible]	96.25
AUTRES							3.14			13.59	3.24	[illegible]	23.64
NIV P 200	11	1.44	43.49	58.44	74.59	4329.75	12559.31	.28	132.36	39.00	93.50	[illegible]	37.64
AUTRES							2.12			46.45	2.12	.92	4.14
NIV P 300	2	2.05	39.00	79.99	53.00	4233.44	13400.00	.29	143.00	39.49	103.71	[illegible]	53.00
AUTRES							1.75			55.50	1.75	[illegible]	[illegible]
NIV P 400	2	4.35	14.86	142.33	38.40	5465.35	5466.67	.13	80.17	33.00	37.73	[illegible]	6.25
AUTRES							4.29			554.00	4.29	[illegible]	6.50
NIV P 600	24	11.16	36.15	403.52	10.37	4186.56	12742.17	.28	143.29	32.20	113.29	.90	9.75
AUTRES							.01			30.75	21.64	.04	1.40
NIV P 700	10	17.33	49.59	844.24	7.00	5969.66	15350.00	.26	125.50	41.60	142.97	.90	6.3
AUTRES							1.81			6.20	1.31	.22	.7
DEPT P	59	2.22	51.42	112.18	44.91	5038.00	12617.68	.28	134.16	42.32	105.29	[illegible]	36.03
AUTRES							7.41			82.64	10.24	.73	5.72

McGill Science - Intra-Departmental Indices

Table III - 1

UN.=.1 SCIENC	IFIU	S	PC	CU	E	C	SA	PT	X	TA	CH	G	[illegible]
NIV P 100 AUTRES	7	[illegible]	100.00	[illegible]	[illegible]	[illegible]	[illegible] [illegible]	[illegible]	[illegible]	[illegible] [illegible]	[illegible] [illegible]	[illegible] [illegible]	[illegible] [illegible]
NIV P 200 AUTRES	7	123.57	63.12	45.34	36.23	32.31	114.31 45.71	91.16	103.23	[illegible] 43.33	95.47 45.71	44.73 44.23	[illegible] [illegible]
NIV P 300 AUTRES	11	[illegible]	43.31	47.38	17.44	15.27	122.36 54.55	66.27	164.52	21.93 3.93	[illegible] 54.55	[illegible] [illegible]	[illegible] 31.67
NIV P 400 AUTRES	19	946.32	23.64	214.11	4.67	6.71	127.15 23.68	[illegible]	[illegible]	11.44 3.77	[illegible] 23.08	[illegible] [illegible]	[illegible] [illegible]
NIV P 600 AUTRES	16	829.67	41.32	342.37	4.45	15.23	142.47 0.00	84.19	125.35	29.33 [illegible]	122.9 [illegible]	[illegible] [illegible]	[illegible] [illegible]
DEPT P AUTRES	56	153.75	67.79	122.27	15.97	14.55	127.52 34.92	77.77	[illegible]	25.74 13.33	[illegible] 34.42	17.44 15.27	[illegible] [illegible]

Montreal Science - Intra-Departmental Indices

Table III - 2

UN.=.2 SCIENC	FIU	A	PE	CU	E	C	SA	PT	X	TA	CH	G	Z
NIV P 100 AUTRES	5	100.00	100.00	100.00	100.00	100.00	100.00 100.00	100.00	100.00	100.00 100.00	100.00 100.00	100.00 100.00	[illegible] 100.00
NIV P 200 AUTRES	4	132.17	67.56	93.05	75.34	76.11	133.77 83.43	37.58	84.49	55.50 54.49	152.[illegible]9 [illegible]	51.21 85.23	49.6 76.5
NIV P 300 AUTRES	14	505.16	46.71	241.18	24.09	56.10	150.13 88.78	47.03	82.28	39.21 13.39	239.55 59.75	53.57 2.95	26.73 26.65
NIV P 400 AUTRES	15	1296.36	37.97	503.33	10.46	52.59	158.21 46.54	32.61	[illegible]	45.12 17.23	143.07 46.54	[illegible] [illegible]	10.97 6.9[illegible]
NIV P 600 AUTRES	18	2093.36	20.00	451.39	3.60	16.21	175.33 0.00	18.62	85.99	13.77 [illegible]	202.14 [illegible]	39.71 [illegible]	4.79 [illegible]
DEPT P AUTRES	62	261.22	67.44	190.20	28.24	53.54	152.43 55.48	39.26	87.54	41.71 22.66	194.30 59.48	57.60 14.79	32.86 27.93

McGill Social Science - Intra- Departmental Indices

Table III - 3

UN.=.ISC. SOC	FIU	A	PE	GU	E	C	SA	PT	X	IA	CH	W	Z
NIV P 100	3	[illegible]	136.33	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AUTRES							[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
NIV P 200	3	141.45	96.84	139.79	125.02	174.75	266.70	169.45	182.69	113.0[illegible]	262.76	231.33	78.59
AUTRES							71.23			73.77	71.20	[illegible]	64.37
NIV P 300	18	331.16	98.99	334.00	19.47	65.01	202.91	134.38	203.12	145.67	163.[illegible]	[illegible]	[illegible]
AUTRES							36.93			[illegible]	36.[illegible]	[illegible]	[illegible]
NIV P 400	11	851.37	90.71	746.42	8.60	64.24	146.73	198.23	147.44	103.[illegible]	144.37	[illegible]	8.93
AUTRES							2.53			[illegible]	[illegible]	.37	3.45
NIV P 600	10	1394.94	56.42	779.79	5.65	43.97	220.41	85.31	2[illegible].36	[illegible]	[illegible]	[illegible]	[illegible]
AUTRES							[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
NIV P 700	9	2519.34	34.95	846.[illegible]	4.22	37.87	214.[illegible]	71.79	187.25	79.52	[illegible]	[illegible]	[illegible]
AUTRES							[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
DEPT P	53	3[illegible]1.31	94.15	248.56	22.69	66.01	194.[illegible]	128.96	181.44	13[illegible].27	174.42	[illegible]	[illegible]
AUTRES							[illegible]			13[illegible]	42.73	[illegible]	[illegible]

Table III - 4

Montreal Social Sciences - Intra-Departmental Indices

UN.=.2 SC. SOC	FIU	1	PC	CU	E	C	SA	PT	X	TA	CH	U	Z
NIV P 100	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AUTRES							[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
NIV P 200	11	161.94	64.23	110.24	35.59	61.27	120.11	86.21	1[illegible].53	93.94	123.7[illegible]	72.73	7[illegible].27
AUTRES							67.29			45.36	67.29	24.22	17.63
NIV P 300	2	224.94	61.86	150.48	39.76	59.93	127.14	88.53	1[illegible]6.39	53.34	137.31	9[illegible].67	55.[illegible]
AUTRES							55.67			29.12	55.67	[illegible]	[illegible]
NIV P 400	2	5[illegible].19	54.32	209.49	28.61	77.34	55.56	39.65	6[illegible].77	53.94	5[illegible].2[illegible]	1[illegible]	8.57
AUTRES							136.31			29.[illegible]	130.31	71.45	27.[illegible]
NIV P 600	24	1245.3[illegible]	57.74	781.22	7.79	59.24	120.98	93.43	1[illegible]4.82	[illegible]	15[illegible].21	63.[illegible]	[illegible]
AUTRES							13.38			16.14	683.51	[illegible]	6.17
NIV P 700	1[illegible]	1899.86	79.65	15[illegible]2.6[illegible]	5.25	83.63	147.54	77.45	95.13	[illegible]7.54	[illegible]49.36	6[illegible]	6.53
AUTRES							57.72			3.95	57.72	3.57	2.96
DEPT P	59	248.[illegible]4	81.57	211.63	33.69	71.3[illegible]	119.72	84.24	1[illegible]1.7[illegible]	48.53	139.6[illegible]	72.32	27.44
AUTRES							[illegible]			43.36	425.86	25.[illegible]3	24.13

McGill Science - Inter-Departmental Index Base

Table IV - 1

UN.=.1 SCIENC	IFIU	A	PZ	CU	F	C	SA	PT	A	TA	CH	[illegible]	Z
P 100		[illegible]	100.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AUTRES							[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
P 200		[illegible]	100.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AUTRES							[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
P 300		[illegible]	100.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AUTRES							[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
P 400		[illegible]	100.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AUTRES							[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
P 500		[illegible]	0.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AUTRES							[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
P 600		[illegible]	100.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AUTRES							[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
P 700		[illegible]	0.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AUTRES							[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
DEPT P		[illegible]	100.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AUTRES							[illegible]			[illegible]	[illegible]	[illegible]	[illegible]

Montreal Science - Inter-De[illegible]rtmental Indices

Table [illegible] - 2

UN.=.2 SCIENC	FIU	B	PE	CU	E	C	SA	PT	X	TA	CH	G	Z
P 100		93.36	97.57	75.49	36.35	28.95	97.43	[illegible]	165.42	[illegible]	47.25	[illegible]	[illegible]
AUTRES							[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
P 200		49.12	95.37	92.30	79.76	65.64	132.32	74.27	142.96	127.53	72.36	[illegible]	[illegible]
AUTRES							[illegible]			76.37	[illegible]	21.53	[illegible]
P 300		[illegible]	105.22	219.35	92.67	[illegible]	137.27	127.77	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AUTRES							[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
P 400		119.23	156.25	177.43	98.59	174.93	[illegible]	83.17	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AUTRES							134.72			173.64	[illegible]	[illegible]	[illegible]
P 500		[illegible]	0.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AUTRES							[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
P 600		213.31	47.22	[illegible]	[illegible]	[illegible]	[illegible]	39.83	[illegible]	[illegible]	77.76	[illegible]	[illegible]
AUTRES							[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
P 700		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AUTRES							[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
DEPT P		119.99	97.06	111.25	67.61	[illegible]	[illegible]	[illegible]	132.11	113.44	[illegible]	[illegible]	[illegible]
AUTRES							[illegible]			[illegible]	[illegible]	[illegible]	[illegible]

Table IV - 3

McGill Social Science - Inter-Departmental Indices

UN.=.ISC. SOC	IFIU	S	PE	CU	E	C	SA	PT	X	TA	CH	G	Z
P 100		92.4[illegible]	54.21	[illegible].31	46.93	23.14	56.73	84.12	46.[illegible]	15.17	62.31	1.34	138.73
AUTRES							254.58			[illegible]	254.58	[illegible]	[illegible]
P 200		1[illegible]6.35	75.95	[illegible].77	141.25	114.[illegible]	137.[illegible]	153.[illegible]	82.[illegible]	43.82	[illegible].41	8[illegible].43	47.50
AUTRES							211.57			34.74	211.97	12[illegible].74	174.[illegible]
P 300		151.95	123.89	144.49	45.59	85.93	97.38	176.07	9[illegible].23	1[illegible]1.47	99.51	[illegible].21	31.[illegible]
AUTRES							171.89			34.11	17[illegible].44	12[illegible].43	[illegible].87
P 400		97.17	237.95	131.30	88.55	10[illegible].55	67.43	247.45	65.82	215.26	63.44	63.97	46.13
AUTRES							27.22			1.[illegible]75	1.63.35	[illegible]	111.76
P 500		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	[illegible]	[illegible]	[illegible]
AUTRES							0.00			1.00	[illegible]	[illegible]	[illegible]
P 600		151.54	74.02	112.17	51.94	58.25	93.84	89.28	74.33	49.35	94.97	93.69	92.[illegible]1
AUTRES							0.00			[illegible]	[illegible]	[illegible]	[illegible]
P 700		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	[illegible]	[illegible]	[illegible]
AUTRES							0.00			0.00	[illegible]	[illegible]	[illegible]
DEPT P		134.59	75.29	116.37	58.63	69.[illegible]1	89.39	146.13	76.75	76.43	9[illegible].03	50.[illegible]1	75.57
AUTRES							165.70			24.[illegible]	312.[illegible]2	6[illegible].83	152.84

Montreal Social Science - Inter-Departmental Indices

Table IV - [illegible]

UN.=.2 SC. SOC	IFIU	A	PE	CU	E	C	SA	PT	X	TA	CH	G	Z
P 100		146.83	41.32	56.85	27.51	15.04	153.43	91.76	88.34	25.32	92.25	[illegible]	[illegible]
AUTRES							36.78			14.47	36.75	[illegible]	122.24
P 200		191.27	38.40	73.44	42.20	30.99	138.65	84.83	85.46	44.64	119.48	[illegible]	[illegible]
AUTRES							28.99			15.31	29.48	12.45	[illegible]
P 300		164.93	59.02	98.17	62.58	61.43	137.47	123.00	91.61	62.26	119.35	63.75	[illegible]
AUTRES							37.54			19.33	37.54	[illegible]	[illegible]
P 400		82.33	34.40	71.33	194.82	138.96	45.28	51.84	51.40	118.94	33.67	[illegible]	[illegible]
AUTRES							211.73			1235.23	211.70	[illegible]	[illegible]
P 500		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	[illegible]
AUTRES							0.00			0.00	0.00	0.00	[illegible]
P 600		223.42	57.35	126.43	48.12	60.82	87.76	91.37	76.42	58.37	112.84	[illegible]	45.35
AUTRES							0.00			0.00	0.00	[illegible]	[illegible]
P 700		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	[illegible]	[illegible]
AUTRES							0.00			0.00	[illegible]	[illegible]	[illegible]
DEPT P		211.46	49.72	38.43	58.63	57.10	97.13	[illegible]	81.63	57.49	[illegible]	[illegible]	[illegible]
AUTRES							54.10			51.91	344.21	[illegible]	[illegible]

(E) Interpretation of Results:

We discuss the results by examining tendencies in the behaviour of the variables and the relationships between them from several points of view: (i) important tendencies from the lowest to the highest FIU level (i.e. from first year courses to graduate courses); (ii) interesting similarities and differences between disciplines; (iii) similarities and differences between universities; and (iv) differences between departments.

We examine the variables and the relationships between them working back analytically from unit cost per student per hour ($\underline{A}$), to the size of a class ($\underline{z}$), according to the chain of relationships:

$\underline{A} = \underline{CU}/\underline{Pe}$; $\underline{CU} = \underline{C}/\underline{e}$; $\underline{C} = \underline{Pt}.\underline{SA}$; $\underline{Pt} = \underline{Ta}/\underline{x}$; $\underline{Ta} = \underline{Pe}.\underline{g}$; $\underline{g} = \underline{e}/\underline{z}$. ... (1).

To draw overall conclusions regarding the behaviour of total cost per FIU ($\underline{C}$), unit cost per student ($\underline{CU}$), and unit cost per student per hour ($\underline{A}$), we synthesize the chain to explain $\underline{C}$ by equating it to its basic components (rather than intermediate composites) as far as $\underline{g}$, yielding the identity:

$$\underline{C} = \frac{Pe \, . \, g \, . \, SA}{x} \quad \ldots\ldots(2)$$

To compare the behaviour of C relative to CU (= C/e), we compare the numerator and denominator of identity (2) with that of e (enrolment), and complete the synthesis by reintroducing the behaviour of Pe to fully explain A in terms of C and CU.

We organize the discussion into a series of related tendencies, titled "Tendency One, Tendency Two...." etc. The Tables which illustrate the tendency under discussion, we label "T", followed by the number of the tendency.

In our comparison of change between FIU levels, we generally compare values for the lowest and for the highest level FIUs because in general these two levels encompass the extreme values of the variables. Where they do not, and the difference seems important, we mention it. The interested reader may make comparisons between intermediate FIU levels for which ever levels and variables are of interest to him. Tables III and IV are particularly convenient for this purpose.

In general, the tendency tables have four rows and 8 columns. One row is reserved for each department. The first column (IDEN) identifies the department and the institution according to the following abbreviations:

McGill Science (MGS)
Montreal Science (MS)
McGill Social Science (MGSS)
Montreal Social Science (MSS)

The second and third columns identify the absolute values of the variable under discussion, the second column stating the value at the 100 FIU level, the third at the highest FIU level. The departmental average (AVR) appears in the fourth column. The first four rows of the fifth column (Symbol "D") identify the difference between the 100 level FIUs and the highest level FIUs by situating the number of times by which the highest level FIUs differ from the 100 level FIUs. For positive differences, we divide the high index number in Table III by 100. For negative differences, we divide the low index number in Table II into 100.

For the three departments other than McGill Science, the sixth, seventh and eighth columns (Symbol INTER) show the index numbers of: the absolute values of 100 level FIUs, those of the highest level FIUs, and those of the departmental average respectively, relative to McGill Science. These figures come from Table IV.

A particularity of Table IV is that both Social Science departments have 700 level FIUs, while neither of the Science departments have them. Since the inter-departmental comparison uses McGill Science as an index base of 100, there is no comparison for the 700 level FIUs in the Social Science departments. We are not sure in what way it is meaningful to compare them to the McGill Science 600 level FIUs, so we do not. Therefore, the HIGH values in column 7, rows 3 and 4 of the tendency tables, refer to the 600 level FIUs. We may compare the 700 level FIUs between the two Social Science departments from Tables II and III.

The departmental average index figures of column (8) include the 700 level FIUs for the two Social Science departments.

We commited several simplifications in aggregating FIUs by level. Firstly, courses having numerical codes of less than 100, we included in the 100 level because they were generally intended for freshmen. There were only two such courses, one in McGill Science, the other in McGill Social Science.* Secondly, all except two of the 300 level FIUs in Montreal Social Science are graduate courses; those of them which are graduate FIUs we included with the 600 level FIUs.

Finally, the raw data from which we compute all other tables appears in Appendix IV, Tables "A" and "B". Table A is the computer print-out of all the FIUs and their respective activities in the form of the accounting framework we developed in Section II of this chapter. Table B is an inventory of professorial workloads. It identifies the professor by his code, his salary, his total workload (x), and the cost of one contact hour of his time (CH). It then lists the activities in which he participates, stating the number of contact hours per academic year involved (Ta), the number of students he sees in any one class of that activity (z), and the weightingfactor $Ta \cdot z$, or simply Tz, used to compute R: the weighted average number of students he teaches per contact hour. For each professor, the inventory identifies R, as well as A, the average cost per student per contact hour for that professor, derived by dividing R into CH. We will use this table in our examination of workload patterns and costs.

---

* No adjustment was made for other CEGEP level courses in these departments.

The data in Tables II, III, and IV are aggregates of Appendix IV, Table A. The data in the tendency tables are from Tables II, III, and IV unless otherwise identified.

With this introductory information in mind, we begin our examination of tendencies.

Tendency One: The Behaviour of Unit Cost per Student per Hour (A)

Table T - 1

Comparisons of "A"

(1) IDEN	(2) 100 lev.	(3) HIGH lev.	(4) AVR	(5) D	(6) 100 lev	(7) INTER HIGH	(8) AVR
MGS	.61	5.06	1.10	+ 8.3			
MS	.51	10.65	1.32	+20.1	83.4	210.3	119.9
MGSS	.57	14.26	1.71	+25.2	92.8	151.5	154.6
MSS	.90	17.03	2.22	+19.0	146.8	220.4	201.4

---

* This amount is higher than its corresponding values in columns (6) and (7) because of the influence of 700 level FIUs, which registers in the departmental average, but not in the level comparisons.

(i) Comparison by Level:

Unit cost per student per hour per FIU increases sharply from the 100 level to the highest FIU level, the highest level normally consisting of graduate courses and seminars. Inspection of column A, Table III—indicates that in McGill Science, the 400 level FIUs (undergraduate honours and general) are slightly more expensive than those of the 600 (graduate) level. In Montreal Science, while the change from the 100 level to the 200 level is a modest 32.17%, the changes from the 200 level onward are very much more pronounced. In McGill Social Science, the largest increase from one level to another (1163.5 points) occurs between the 600 and 700 levels (both graduate). In all departments there is a decided distinction in the magnitude of costs and their changes between FIUs up to the 300 level and those beyond the 300 level. Anything beyond the 300 level jumps in cost by relatively substantial amounts. Level 400 FIUs seem to be closer in _genre_ to graduate courses.

(ii) Comparison by Discipline:

The departmental average "A" (Table T-1, Col. 4) is generally higher for the social science departments than it is for the science departments, the simple mean of means for the science departments being $1.21, that of social science departments, $1.97. We shall see in detail that this phenomenon has to do with the very large number of relatively cheap hours that science students spend in laboratories, under the supervision of student demonstrators. We hesitate to suggest that the grand means we quote here have any broader significance beyond the four departments we examine; comparing an average of two with another average of two is not a valid statistical technique by which to draw inferences about the population. On the whole, the inter-level rate of increase (T-1, Col. 5) is higher in the social science than in the science departments.

(iii) Comparison by University:

The average values of T-1, Column 4 do not permit us to say unequivocally that one university is more or less expensive than the other, on the whole, though comparing mean of means by university, McGill comes out at $1.41 and Montreal at $1.77.

(iv) Comparison by Department:

Compared to McGill Science, the three other departments were more expensive in terms of the departmental average A, for which indices appear in T-1, Col. 8. Montreal Social Science was the most expensive of the four. It is interesting to notice that while the other departments (excluding Montreal Social Science) were cheaper than McGill Science at the 100 level FIUs, they became very much more expensive at the highest level FIUs, thereby making them more expensive on the average.

Tendency Two: The Behaviour of Unit Cost per Student per FIU (CU) and Student Contact Hour Commitment per FIU (Pe).

By definition, $A = CU/Pe$, therefore the tendencies we examined with respect to "A" should be examined in terms of the tendencies of CU and Pe.

TABLE T - 2

Comparison of "CU"

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
IDEN	100 lev.	HIGH lev.	AVR	D	100 lev.	INTER HIGH	AVR
MGS	93.24	319.23	114.01	+ 3.4			
MS	70.38	317.01	126.83	+ 4.5	75.49	99.3	111.2
MGSS	45.98	412.38	132.68	+ 9.0	49.31	112.2	116.4
MSS	53.01	844.24	112.18	+15.9	56.85	126.4	98.4
			Comparison of "Pe"				
	hrs.	hrs.	hrs.				
MGS	152.58	63.04	103.43	-2.4			
MS	148.86	29.77	100.39	-5.0	97.5	47.2	97.1
MGSS	82.71	28.91	77.87	-2.9	54.2	74.0	75.3
MSS	63.04	49.59	51.42	-2.4	41.3	57.4	4[illegible]

(i) Comparison by Level:

The figures in T-2, Column 5, indicate that in all departments CU increased from the lowest to the highest FIU level, while Pe decreased. In all cases except for Montreal Science, the increases in CU are more important than the decreases in Pe. The meaning of this is that although students spend less time in class per FIU at the upper levels than they do at the lower levels, unit cost per student increases nevertheless, and it increases more than enough to offset the decreased contact hour time that students have in the upper FIU levels. The general reason for which this drop in Pe occurs is that in the upper level FIUs students normally have fewer tutorials and laboratories, most of their contact time being expended in lectures and seminars. We shall examine this statement in more detail when we discuss the counterpart of student contact hours—professorial and "AUTRES"[28] contact hours.

McGill Science's 400 level FIU value for "A" is higher than that of the 600 level, more because of a larger relative drop in Pe, than the increase in CU. (See Table III-1). An examination of the data[29] indicates that Pe is lower at the 400 level than at the 600 level because the FIUs are mainly 13 week courses at the 400 level, and range from 13 to 50 week courses at the 600 level; yet on the whole, the number of hours per week per FIU that the student attends class does not differ much between the two levels.

---

[28] "AUTRES" refers to demonstrators, tutors, correctors, and hourly-paid part-timers. See Table II-1.

[29] See Appendix IV, Table A, pages MGS 9-12.

The large changes in "A" after the 200 level in Montreal Science occur because of large changes in both Pe and CU from one level to another, the relative importance of the changes in each variable varying from one level to another. On the whole, the increase in CU is only slightly greater than the decrease in Pe.

The very large increase of "A" in McGill Social Science from the 600-700 level FIUs occurs because the decrease in Pe is relatively much greater than the increase in CU (Table III-3). This occurs largely because students have more contact hours per week per FIU at the 600 level than at the 700 level (Appendix IV, Table A, pages MGSS 5-7), while on the whole the length of the courses in weeks does not differ much between the two levels. In all four departments, the very large rise in "A" from the 300 to the 400 level FIUs occurs because CU rises while Pe falls, but the rise in CU is relatively much greater than the fall in Pe (Table III).

(ii) Comparison by Discipline:

On the whole, there is very little difference by discipline of CU, the mean of means being $120.42 in the science departments and $122.43 in the social science departments. The real difference occurs in Pe, where the mean of means in the science departments in 101.9 hours and that of the social science departments 64.6 hours, explaining why science "A" is cheaper than social science "A". The main reason for this is that in the social sciences, students spend no time in laboratories. While students spend more time in contact in the sciences than in the social sciences, we shall see that the science departments enjoy economies of hourly wages in laboratories, partly explaining why the average CU differs little between the two disciplines; or how science can "process" more student contact hours for every dollar per student than social science.

On the whole, in the science departments the inter-level rate of increase in CU differs little from the decrease in Pe, the rates being 3.95 and -3.7, respectively. In the social science departments, the inter-level rate of increase in CU is much greater than the decrease in Pe, the rates being 12.45 and -2.65, respectively. We now see that the reason for the higher inter-level rate of increase in "A" for social science relative to science is largely on account of the relatively larger increase in CU than the decrease in Pe for the social science departments.

(iii) Comparison by University:

TABLE T - 2 (a)

Means of Means by University

	CU	Pe
McGill	123.34	90.6
Montreal	119.5	75.9
Mg/M	103.2	119.4

(Source Table T-2)

We mentioned in section (iii) of Tendency One that McGill's "A" is $1.41 and Montreal's $1.77. Analyzing "A" in terms of the mean of means for CU and Pe by university, CU in McGill is $123.34, in Montreal $119.50. Pe in McGill is 90.6 hours and in Montreal 75.9 hours. Thus, between universities the relative difference in Pe is more important than the relative difference in CU, as far as "A" is concerned. In other words, McGill "processes" more hours of student contact time for every dollar per student than does the University of Montreal.

(iv) Comparison by Department:

Compared to McGill Science, the other departments except for Montreal Social Science, were more expensive in terms of CU, for which indices appear in T-2, Column (8). In terms of Pe all three were lower than McGill Science, however, Pe for Montreal Social Science was sufficiently lower so that "A" still comes out higher than that of all other departments, despite its relatively lower average CU. Except for Montreal Social Science, "A" is cheaper at the 100 level and costlier at the highest level for the other departments relative to McGill Science on account of the following factors: At the 100 level, in all three departments, CU is lower than that of McGill Science. The same is also true for Pe, (T-2, Col. 6), however, the relation-index of Pe, making "A" for McGill Social Science cheaper than "A" for McGill Science. In Montreal Social Science, however, the index of CU is higher than the index of Pe, making "A" for Montreal Social Science higher than "A" for McGill Science.

At the higher level FIUs (T-2, Col. 7), the following factors explain why all other departments have a higher "A" than McGill Science: In Montreal Science, the index of CU is almost the same as that of McGill Science, however, the index of Pe is very much lower (47.2) than that of McGill Science. In the case of the other two departments, CU is higher and Pe lower than that of McGill Science. In both cases, Pe is relatively lower than CU, meaning that the higher "A" occurs because at the higher levels the other departments process fewer contact hours for every dollar per student than does McGill Science. It appears that McGill Science's relative cheapness with respect to average "A" occurs largely because it runs a cheaper operation per student-hour at the higher levels compared to the lower levels relative to the other universities.

As we continue to explore the chain of relationships, we shall develop a clearer understanding of why these relationships exist the way in which they do.

Tendency Three: The Behaviour of Total Cost (C) and FIU Enrolment (e).

While we shall have more to say about the behaviour of Pe in conjunction with its counterpart Ta, we now explore the nature of variation in unit cost per student per FIU (CU). We have defined CU = C/e , therefore, the tendencies we examined with respect to CU should be explained in terms of the relationship between total cost and enrolment.

TABLE T - 3

Comparisons of "C"

(1) IDEN	(2) 100 lev	(3) HIGH lev	(4) AVR	(5) D	(6) 100 lev	(7) INTER HIGH	(8) AVR
MGS	45190	6883	8824	-6.6	28.95	30.8	75.4*
MS	13082	2119	6657	-6.1	20.18	58.2	68.23
MGSS	9120	3453	6020	-2.6	15.64	60.8	57.10
MSS	7066	5909	5039	-1.2			

Comparisons of "e"

	#	#	#				
MGS	484.6	21.5	77.4	-22.5	38.35	31.0	67.8**
MS	185.9	6.7	52.4	-27.8	40.93	51.9	58.6**
MGSS	198.4	8.4	45.4	-23.7	27.51	48.12	58.0
MSS	133.3	7.0	44.9	-19.0			

---

* The intermediate levels have higher indices than McGill Science and higher indices than that of Montreal Science's 600 level.

** Intermediate levels had higher indices than the highest level.

(i) Comparison by Level:

The figures in T-3, column 5, indicate that in all departments total cost per FIU decreased from the lowest to the highest FIU level, while enrolment per FIU also decreased, but by very much more. In other words, cost per student per FIU increases from one level to another even though total cost per FIU decreases, because enrolment per FIU decreases more than proportionately.

Several factors explain the very substantial decreases in enrolment per FIU as level increases. Firstly, each discipline serves not only students specializing to their final years in that discipline, but also students specializing in other disciplines, or specializing in nothing at all, such that enrolments in the discipline at hand may be quite large at the level of introductory and intermediate courses, but quite small at the level of the more specialized courses. Unfortunately, we have no data to verify this statement because student accounting at our universities is not organized along the lines we suggested it may be organized in Section II of Chapter III. Our familiarity with the local educational situation leads us to believe that the statement is nevertheless a reasonable one.

Secondly, there are generally more FIUs at the higher than at the lower FIU levels. Generally, from the 300 level upward, FIUs proliferate. This undoubtedly reflects the variety of specializations within the disciplines open to students once they have completed the introductory requirements. If we combine the decreased total demand for FIUs with increased numbers of FIUs from which those who specialize may choose, it is apparent that enrolment per FIU should decline markedly as level increases.

The reader may observe from Tables II and III that in general, the relatively large increase in CU from the 300 to the 400 level occurs more on account of the decrease in e than the increase in C.

(ii) Comparison by Discipline:

TABLE T - 3 (a)

Mean of Means by Discipline

	C	e
S	7740	64.9
SS	5530	45.2
S/SS	139.9	143.6

(Source: Table T-3)

We mentioned in Section (ii) of T-2 that the mean of mean CU differs little from one discipline to the other, but that science is a bit lower than social science. We examine the relationship C/e to see how it produces this result. As we may expect, it happens for different reasons in each discipline. Science has a higher C per FIU on the average than social science, the figures being mean of means of \$7740 and \$5530, respectively. Although science courses on the average cost more than social science courses, they also had higher enrolment on the average, the mean of means being 64.9 and 45.2 students for science and social science, respectively. The relatively higher cost of the science courses is more than offset by their higher relative enrolment, making them slightly less expensive than social science courses, in terms of CU.

With regard to comparative inter-level rates of change of the variables between the two disciplines, we observe the following factors: The inter-level rate of decrease in C is much higher for the sciences than for the social sciences, the mean of means (T-3, Col. 5) being 6.4 times and 1.9 times, respectively. We shall examine the reasons for this difference when we discuss the components of C. In the science departments the mean of means decrease in e is 25.2 times, while in social science it is 21.4 times. We may now understand why the inter-level increase of CU is higher for social science than it is for science: although the inter-level rate of change in e does not differ appreciably between the two disciplines, the inter-level rate of change of C is much greater in science than in social science. In other words, unit cost per student per FIU increases between levels in the social sciences more than in the sciences because although enrolment falls with level in both, total cost per FIU in science falls by much more than it does in social science.

(iii) Comparison by University:

TABLE T -3 (b)

Mean of Means by University

	C	e
MG	7422	61.4
M	5848	48.6
MG/M	126.9	126.3

(Source: Table T-3)

CU in McGill is very slightly higher than CU in Montreal (T-2, section iii), because C for McGill's FIUs is more expensive on the average than Montreal's (the mean of means being \$7422 and \$5848, respectively), while McGill also has more enrollees per FIU than Montreal; (the mean of means being 61.4 and 48.6 enrollees, respectively). While McGill's C was 126.9 of Montreal's, its e was 126.3. Thus, McGill's enrolment relative to its cost per FIU is very slightly less than Montreal's, making McGill's CU very slightly higher than Montreal's.

(iv) Comparison by Department:

We may explain why CU is higher than McGill Science, for Montreal Science and McGill Social Science, and slightly lower for Montreal Social Science by examining the relationship of C and e in T-3, Col. 8. All three departments have lower C and lower e per FIU on the average, than does McGill Science. Remembering that CU = C/e, what matters is the relative value of the ratio C/e between the departments—not the individual absolute values of the two variables. In the case of Montreal Science and McGill Social Science, Column (8) of T-3 indicates that the ratio

C/e is 75.4/67.8 and 68.2/58.6, respectively. Therefore, CU comes out higher than that of McGill Science. However, in the case of Montreal Social Science, the ratio C/e is 57.1/58.0, making its CU slightly lower than that of McGill Science. The meaning of this information is that while Montreal Science and McGill Social Science were cheaper than McGill Science in terms of total cost per FIU, neither of them processed a relatively large enough number of students through the FIUs to be more economical in terms of unit cost per student per FIU. The reverse is true in the case of Montreal Social Science.

Tendency Four: The Composition of Total Cost (C).

Having examined the relationship between CU and e, as well as factors that we believe conducive to the behaviour of e, we now examine the components of C to account for its variations.

Though we have defined C = Pt . SA, we cannot use this relationship for analysis of aggregate values because Pt is a fraction representing the relationship Ta/x. Regardless, the value of Pt for any level or for any

TABLE T - 4

Comparisons of Pt (for professors)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
IDEN	100 lev	HIGH lev	AVR	D	100 lev	INTER HIGH	AVR
MGS	.36	.30	.28*	-1.2			
MS	.65	.12	.26	-5.4	180.1	39.8	90.9
MGSS	.32	.23	.41**	-1.4	88.1	89.3	146.1
MSS	.33	.26	.28	-1.3	91.8	91.4	99.4

Comparisons of SA (for professors)

	$	$					
MGS	10190	14517	12994	+1.4			
MS	8909	15620	13580	+1.7	87.43	107.6	104.5
MGSS	5986	12835	11616	+2.1	58.75	90.89	89.3
MSS	10539	15550	12617	+1.5	103.43	87.76	97.1

Comparisons of Ta (for professors)

	hrs.	hrs.	hrs.				
MGS	285.5	83.9	73.6	-3.4			
MS	200.0	27.9	83.51	-7.3	70.1	32.8	113.44
MGSS	43.3	34.0	56.45**	-1.3	15.1	49.5	76.73
MSS	72.3	41.6	42.32	-1.	25.3	38.3	57.48

Comparisons of x (for professors)

	hrs.	hrs.	hrs.				
MGS	149.3	187.5	164.3	+1.24			
MS	247.6	215.4	217.1	-1.15	165.8	114.9	132.1
MGSS	69.3	129.8	126.1	+1.90	46.4	74.5	76.7
MSS	131.9	125.5	81.6*	-1.05	88.3	76.4	81.6

Comparisons of CH (for professors)

	$	$	$				
MGS	81.76	100.40	98.37	+1.2			
MS	38.63	78.09	75.06	+2.0	47.25	77.78	76.30
MGSS	51.11	106.06	89.15	+2.1	62.51	94.97	90.63
MSS	75.42	142.97	105.29	+1.9	92.25	112.84	10[illegible]4

---

* The average does not fit between the values of columns 2-3 because there are lower values at the intermediate levels.

** The average does not fit between the values of columns 1-3 because there are higher values at the intermediate levels.

department, it makes a difference to C whether the absolute values underlying Pt are high or low. We illustrate the comparative behaviour of Pt, but we explain the composition of C primarily in terms of SA, Ta and x. It will also be useful to consider CH. Another element of total cost is the budget for demonstrators, tutors, correctors, and hourly-paid part-time staff. These latter kinds of personnel we refer to from here on as "AUTRES", according to their code in Tables II, III and IV. We open the discussion with a presentation of the comparative values of Pt, SA, Ta, x, and CH.

In our analysis of professorial workloads, we also refer to the distribution of professors' contact hours (Ta) between activities at different levels. This information appears in Table T-4 (a).

The departmental profiles of professorial staff numbers, their total, average, hourly average cost, as well as their total and average workloads per professor appear in Table T-4 (b).

TABLE T -4 (a)

Professor's Workload Distribution by Department, Level and Activity (in hours)

LEVEL AND ACTIVITY		MGS	MS	MGSS(2)	MSS
1. Lectures and Graduate Seminars	100	279	208	104	710
	200	312	403	250	351
	300	403	468	1040	117
	400	402	351	702	-
	600	1369	468	416	773(3)
	700	-	-	312	416
Sub-total		2765	1898	2824	2367
2. Tutorials	100	590	65	26	52
	200	260	0	-	26
	300	247	26	104	-
	400	65	572(1)	-	78
	600	0	0	-	-
	700	-	-	-	-
Sub-total		1162	663	130	156
3. Laboratories	100	0	727		
	200	39	487		
	300	39	882		
	400	156	546		
	600	0	0		
	700	-	-		
Sub-total		234	2642		
GRAND TOTAL		4161	5203	2954	2523

---

(1) Includes industrial visits and term project contact hours.

(2) Does not include exceptional cases of a substitute temporary lecturer and a temporary visiting professor, contributing a total of 104 hours in two FIUs at the 400 level.

(3) Includes 300 level Graduate Seminars.

(Source: Appendix IV, Table A).

TABLE T - 4 (b)

Professor's Profiles by Department(1)

	MGS	MS	MGSS	MSS
1. Number of Professors(2)	31	26	24	20
2. Total Salary Bill (SA per prof)	379850	323183	269660	270064
3. Average Salary per Professor (2/1)	12253(a)	12430	11235	13503
4. Total Contact Hours (x per prof)	4161	5203	2954	2523
5. Average x per prof. (x/# prof.)	134(b)	200	123	126
6. Average CH per prof. (CH per prof/# prof.)	121(c)	82	90	124
(a) Value of 1 standard deviation ($)	5140	4526	4357	4460
(b) Value of 1 standard deviation (hrs.)	87	83	34	47
(c) Value of 1 standard deviation ($)	74	88	35	59

(1) All values to nearest dollar or nearest number of hours.

(2) Does not include small contributions to MGS not paid by the department, nor the temporary substitute lecturer and the temporary visiting professor at MGSS.

(Source: Appendix IV, Table B).

In Tables T-4 (c) and (d), we provide comparative salary and workload data for "AUTRES". In their case, Pt = Ta, SA per hour is the same as CH, and x does not apply. Therefore, we provide values for SA and Ta, in Table T-4 (c). In Table T-4 (d), we provide the wage bill for "AUTRES" by department and by FIU level. In Table T-4 (e), we compare the relative wage bill of professors and "AUTRES" by department.

TABLE T - 4 (c) (AUTRES)

Comparisons of Ta

(1) IDEN	(2) 100 lev	(3) HIGH lev	(4) AVR	(5) D	(6) 100 lev	(7) INTER HIGH	(8) AVR
MGS^1	1143.3	43.1	159.2	-27.0			
MS ^{1}	732.3	74.8	165.9	- 9.7	64.0	173.7	104.2
MGSS^1	292.7	4.6	38.2	-63.3	25.6	-	24.0
MSS^2	190.6	6.2	82.6	-30.7	16.7	-	51.9

Comparisons of SA

(1) IDEN	(2) 100 lev	(3) HIGH lev	(4) AVR	(5) D	(6) 100 lev	(7) INTER HIGH	(8) AVR
MGS^1	8.55	2.02	2.98	- 4.2			
MS ^{1}	8.21	3.82	4.55	- 2.1	96.03	188.7	153.00
MGSS^1	21.76	.55	4.94	-39.6	254.58	-	165.7
MSS^2	3.14	.42	1.61	- 7.5	36.78	-	54.1

---

(1) Level 100-400 only

(2) Level 100-700.

TABLE T - 4 (d)

Wage Bill of "AUTRES" by Level and Department

$

LEVEL	McGILL SCIENCE	MONTREAL SCIENCE	McGILL SOCIAL SCIENCE	MONTREAL SOCIAL SCIENCE
100	43973	30085	18401	10182
200	17666	26390	4050	3816
300	9167	19495	10156	1168
400	10500	11446	150	5045
500				13534
600				1125
700				
TOTAL	81306	87416	32757	34870

(Source: Appendix IV, Table A).

TABLE T - 4 (e)

Comparison of Professorial and "AUTRES" Wage Bill

DEPARTMENT	PROFESSORS	UTRES	RATIO PROF/AUTRES
McGill Science	379850	81306	4.6
Montreal Science	323183	87416	3.7
McGill Social Science	269660	32757	8.2
Montreal Social Science	270064	34870	7.7

(i) Comparison by Level: (Ref. Table T-4).

We demonstrated in T-3 (i) that in all departments total cost per FIU decreases from the lowest to the highest FIU level. We examine the components of C in terms of (SA . Ta/x) to discover how and why this happens. It is interesting to note that in all departments, the average salary per FIU (SA) increases from the lowest to the highest FIU level, with the highest rate of increase being in the McGill Social Science department. (See Table T-4). This indicates that the departments generally use more expensive staff at the higher FIU levels, implying more senior staff in terms of rank or experience. This is to be expected.

For total cost per FIU to decrease, the increasing salary cost must be offset by the combination of hours (Ta) and total teaching load (x) expended per FIU at each level. Rising salaries per FIU should be offset by diminishing hours (Ta) per FIU and increasing total workloads (x) of the staff teaching at the higher levels. This occurs in different ways in different departments.

In all departments with the exception of McGill Social Science, the rate of decrease in Ta is higher than the rate of increase in SA, however, this latter department also enjoys the highest rate of increase in x. In McGill Science the increase in salary level is not only more than compensated by the decrease in hours of teaching at the higher levels, but the value of x increases as well.

In Montreal Science, x decreased moderately from the lowest to the highest FIU level, however, the decrease of Ta was very substantial (-7.3 times) and more than enough to compensate for the increased salary level (+1.7 times) and decreased total workloads (-1.15) of the kind of staff commited to the higher FIUs.

In Montreal Social Science, the increase in salary level was somewhat more than offset by the decrease in Ta, while x remains fairly steady from the lowest to the highest FIU level.

Another way of examining what happens to C as a result of increasing salaries, decreasing hours of teaching and using staff with varying total workloads per level, is to view the changes in CH in conjunction with SA, Ta, and x.

CH is the cost per hour of professorial time, i.e. SA/x. In Table 4-A, CH is average hourly cost per FIU of professorial time. In all four departments it increases. It increases least in McGill Science (1.2), where the average salary level per FIU increases by 1.5 times, while x also increases by 1.2 times. In Montreal Social Science and in Montreal Science, the level of SA increased but x decreased, therefore, on the average the inter-level change in CH comes out somewhat higher than that of McGill Science (1.9 and 2.0, respectively). In McGill Social Science, x went up by 1.9 times, but salary increased 2.1 times causing the inter-level change in CH to be higher than that of McGill Science where the relative increase in SA was not as great as the relative increase in workloads. Thus, for different reasons and to differing extents in the departments, CH increased in all, however, the reductions in Ta more than offset the increases in CH; that is, even though average cost per hour per FIU increases from the 100 to the highest FIU level, the decrease in the number of hours is more than enough to offset their added unit expense. This partly explains how the average of total cost per FIU decreases as FIU level increases.

At this point we offer some remarks about inter-level staffing policy in the departments. We have already mentioned that salary levels increase with FIU level, implying the use of more senior staff. In two departments, the more senior the staff, the heavier their total contact hour workloads on the average (McGill Science and McGill Social Science). In two other departments, Montreal Science and Montreal Social Science, the reverse is true. While a sample of two has its obvious limitations, it is interesting to note that the distinction here is an inter-institutional rather than an inter-disciplinary one. In all departments the average Pt per FIU decreases with level. This stands to reason , as the lower level FIUs require many more teaching hours per FIU than do the upper level ones.

As "AUTRES" also incur costs to the department which figure into the total cost per FIU, we consider inter-level changes in the use of these instructors. The relative importance of "AUTRES" to professors appears in T-4 (e), where we observe that for the department as a whole, the wage bill for professors is at least 3.7 and at most 7.7 times that of "AUTRES". In all departments, as FIU level increases the use of "AUTRES" decreases. The evidence of this appears in Tables T-4 (c) and T-4 (d). Generally, the 100 level FIUs consume between 1/3 and 1/2 of the total budget for "AUTRES", and only in Montreal Social Science does the use of "AUTRES" extend into the 600 and 700 level FIUs. These consisted mainly of hourly-paid part-timers and correctors.

Since the quantity of FIUs increase as level increases, the change in average use of "AUTRES" per FIU from the 100 to the high level FIUs is even more dramatic than the decrease in the total wage bill. According to Table T-4 (c), on the average a high level FIU uses from 27 to 63.3 times fewer hours of "AUTRES" than does the 100 level. The change is particularly dramatic in the case of McGill Social Science, where many of the classes at the 400 level are honours courses.

Since pay rates do not usually vary according to FIU level (except in Montreal Science where they increase), the declining values of hourly SA per FIU from the lowest to the higher FIU levels (Table T-4 (c)) simply means that "AUTRES" are spread thinner over the increasing number of FIUs as level increases. The average use pattern of "AUTRES" seems to conform to the negative sloping demand curve, with the exception of Montreal Social Science.

TABLE T-4 (f)

Hourly Price and Use of "AUTRES

INSTITUTION AND DISCIPLINE	"CHARACTERISTIC" SA/hr. ($)	Ta AVERAGE PER FIU (FOR THE DEPARTMENT) HRS.
McGill Social Science	25.04	38.2
McGill Science	12.82	159.2
Montreal Science	9.62	165.9
Montreal Social Science	5.00	82.0

(Source: Appendix IV, Table A, and T-4).

While it may be tempting to suggest that demand for "AUTRES" is a function of their hourly wage rate, we hesitate to advance this hypothesis for several reasons. Firstly, demand and supply are not quite independent in the university setting.

Many students are hardly independent enough to set a supply price. This is particularly true where there exists a supply of students demanding income in the form of teaching assistantships. Since the pay rates for "AUTRES" depend on administrative decisions within the institution, and students are to some extent a captive market, the institution may set the supply price and the pattern of demand, with some regard to student expectations, but perhaps not much more than that. The negotiability of assistantships doubtless varies from one department, and sometimes even one professor to another.

Secondly, the use of "AUTRES" may be more a function of academic policy than of price over a wide price range. We gathered some evidence which seems to support this notion. For example, the McGill Science department avoids the use of student instructors for tutorials as a matter of policy, while its pay-rate is second highest of the four. Its avoidance of student instructors does not depend upon ability to pay. It claims to be dissatisfied with student feedback and quality of instruction from the employment of student tutors. In the McGill Social Science department, where most of the FIUs are higher level, more specialized courses with fairly low enrolments, the use of student instructors may be neither necessary nor appropriate, particularly within traditional pedagogic structures. Despite some price difference between the McGill Science and the Montreal Science departments, there was little difference in average usage, suggesting that demand is somewhat price inelastic over the price-range at hand. This inelasticity seems to suggest that manpower requirements in laboratories are more important than price in determining use rates.

(ii) Comparison by Discipline:

In Table T-3, section (ii), we mentioned that on the average, C is higher for science than for social science. The reasons for this are not uniform from one department to the other.

TABLE T - 4 (g)

Mean of Means by Discipline (professors)

	Ta	SA	x	CH
Science	78.5	13287	190.6	86.7
Social Science	49.4	12116	104.2	97.2
Science/Social Science	158.9	109.6	182.9	89.20

(Source: T-4).

In the science departments, the average cost per hour of professorial time per FIU was 89.2% of that for social science, (because higher salary per FIU in science is more than offset by higher total workloads), however, the number of hours per FIU on the average in science is 158.9% of the value for social science. Thus, the moderately lower average CH per FIU in science is more than outweighed by its much higher Ta compared to that of social science. The reasons for the relatively high Ta in science as compared to social science are not uniform between the two science departments. According to Table T-4 (a), the Montreal Science professors have fewer lecture hours than the McGill Science professors. While tutorials consume very few professorial hours and laboratories very many in Montreal Science, the reverse is true in McGill. In Montreal Science there are few tutorials to begin with, and tutors handle most of those which do occur, except at the 400 level. In McGill Science there are many tutorials, but the professors staff them, as a matter of policy. While demonstrators handle most of the contact hour work in McGill Science's laboratories, in Montreal Science's labs both professors and demonstrators work with the students.

A glance at Table T-4 (a) suggests that on the average, total contact hours expended on lectures do not differ very much between the disciplines, however, the added tutorial commitments of McGill Science and the added lab comitments of Montreal Science make professorial workloads per FIU relatively higher in science than in social science.

This is especially so given the fact that tutors handle most of the tutorials in the social science departments, thereby explaining the relatively low total professorial contact hours compared to McGill Science, and in a way, Montreal Science. In this latter department, the total tutorial hours which professors handle is heavily influenced by activity at the 400 level, most of which is industrial visits and term projects supervised by professorial staff.

With regard to the value of x—it is evident from the data in Table T-4 (b) that while the science departments have more contact hours and more staff than the social science departments, in both science departments there is proportionately less staff to contact hours, yielding a higher average workload per professor in science than in social science.

This is particularly evident in the case of Montreal Science where workloads appear to be unusually high.

The inter-disciplinary use of "AUTRES" is also interesting to compare.

TABLE T - 4 (h)

Mean of Means by Discipline ("AUTRES")

	Ta	SA
Science	162.5	3.77
Social Science	60.4	3.28
Science/Social Science	269.0	114.9

(Source: T-4 (c)).

The average use of "AUTRES" also tends to make science more expensive in terms of total cost per FIU compared to social science. Both the grand mean hourly wage rate per FIU and the grand mean quantity of hours of "AUTRES" time employed is higher in science than in social science, though the number of hours is evidently more critical than the average hourly wage differential per FIU. We may gage the total differential in wage bill between science and social science's use of "AUTRES" from Table T-4 (d), where the total values are $81,306 and $87,416 for the two science departments, compared to $32,757 and $34,870 in the social science departments. Lab requirements are most probably the main difference between the disciplines.

In T-3 (ii), we mentioned that the inter-level rate of decrease in C is much higher for science than for social science. We examine why this occurs:

TABLE T - 4 (i)

Mean of Changes by Discipline (Professors)

	Ta	SA	x	CH
Science	-5.3	+1.6	+.05	+1.6
Social Science	-1.5	+1.8	+.43	+2.0
Science/Social Science	353.3	88.8	11.6	80.0

(Source: T-4).

In science the average rate of change in Ta is obviously the most significant explanation for the higher inter-level rate of decrease of C for science relative to social science. It is also true that the rate of salary increase between low and high level FIUs was also less in the case of science than social science, but that of x was proportionately much less. The result is that average cost per contact hour in science increased by less than that of social science from the lowest to the highest FIU level, however, the relatively substantial decrease in Ta more than offset the influence of this factor, to yield a much greater reduction of C from the lowest to the highest FIU level for science compared to social science.

The reasons for which Ta decreases more rapidly in science than in social science may be appreciated from Table T-4 (a): professor-staffed tutorials fall off very markedly from the lowest to the highest FIU level in McGill Science. The same is true for laboratories in Montreal Science. At the higher FIU levels, science has fewer laboratory periods and tutorials than at the lower levels. While the fall-off in tutorials also applies to the social sciences, these latter departments start from a lower base for tutorials and have no labs, therefore, the rate of decrease is bound to be much higher in science.

The inter-level change in lectures and seminars for social science is not very great, the mean of means at the 100 level being 407 contact hours, and 364 at the 700 level. In science, however, the mean of means lecture and seminar contact hours increases from 243.5 at the 100 level to 917 at the highest level. However, the number of FIUs also increases markedly from the lowest to the highest FIU level. From Table II we derive a mean of mean number of science FIUs to be 4 at the 100 level and 16 at the 600 level. The rate of increase in lecture contact hours is 3.7, while that of FIUs is 4, therefore, the average number of lecture hours per FIU falls with increased FIU level in science as well. A technical difficulty in this comparison, as in others, is the smallness of the number of items to be averaged at the 100 level. Especially in McGill Science, the behaviour of the 100 course overshadows everything else that happens at that level, because it is very large relative to the other two FIUs at that level.

(iii) Comparison by University:

In T-3 (iii) we mentioned that on the average C per FIU is higher in McGill than it is in Montreal, the mean of means being $7,422 and $5,848, respectively. We examine the composition of C by university to analyze why this occurs.

TABLE T - 4 (i)

Mean of Mean Changes by University (Professors)

	Ta	CH
McGill	65.1	93.8
Montreal	62.9	90.2
McGill/Montreal	103.5	104.0

(Source: T-4).

McGill carried more professorial contact hours per FIU at a higher hourly cost of professorial time per FIU on the grand average than did Montreal.

(iv) Comparison by Department:

We mentioned in T-3 (iv) that in all three departments, the total of C per FIU is cheaper than that of McGill Science. Comparing CH and Ta in Table T-4, column 8, we observe that Montreal Science had 11.3% more contact hours on the average than did McGill Science, but at only

76% of the average cost per hour. In McGill Social Science, both the average cost per hour and the average number of hours per FIU were lower. In the University of Montreal, average cost per hour per FIU was 7.04% higher than McGill Science, however, it only has 57.5% as many hours. Different departments have lower C than McGill Science for a combination of different reasons.

Looking at Table T-4 (b), we may explore these differences by professor rather than by FIU. On the average, by professor as well, CH is cheaper in Montreal Science and in McGill Social Science, somewhat higher in Montreal Social Science all compared to McGill Science. This occurs on account of the following factors: Compared to McGill Science professors, Montreal Science professors had 1.4% higher salaries, but they carried 25% more contact hours, the main factor being their comparatively heavy contribution to laboratories. In Table T-4 (a) we observe that even though Montreal Science professors spend fewer contact hours in lectures and in tutorials than their McGill counterparts, their extra commitment to laboratories more than compensates this factor.

Compared to McGill Science professors, McGill Social Science professors had slightly lower salaries, but very much lighter contact hour workloads. This is apparent from the evidence of T-4 (b). It happens because in McGill Social Science, professors hardly spend contact hours on tutorials, while they do in McGill Science (See T-4 (a)). Of course the former have no labs.

Montreal Social Science professors have higher average salaries and lower contact hour workloads than McGill Science professors. They give fewer lectures and very much fewer tutorials. Therefore, CH is relatively high for them.

Since the number of FIUs does not differ very much between departments, the tendencies of averages we related with respect to professors is consistent with those we related with respect to FIUs.

We have no explanation of the historical or institutional reasons why salaries and contact hours are not more uniform between the departments. Nor do we offer any value judgement concerning the appropriateness of any relative level of CH. Much depends on the priorities of the department, which involve more than contact hour instruction. Time spent in instruction probably has an opportunity cost in terms of other activities. Since we have no valid measure of these opportunity costs, we offer no assessment of the appropriateness of any particular combination of workload and salary levels.

Having explored the composition of total cost per FIU, by level, by discipline, by university and by individual department, we must now go further behind the composition of Ta, which is a composite equal to (Pe . g), or the number of hours the student attends class per FIU, multiplied by the number of groups needed to handle the enrolment of the FIU. Ta, or staff contact hour requirements, derives from the number of contact hours the students need per FIU.

Tendency Five: The Behaviour of Ta in Terms of Pe and g:

TABLE T - 5

Comparisons of *g* (professors)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
IDEN	100 lev	HIGH lev	AVR	D		INTER	
					100 lev	HIGH	AVR
MGS	10.6	1.1	1.9	-9.5			
MS	2.8	1.0	1.6	-2.8	26.3	88.9	86.9
MGSS	1.0	1.0	1.1	nil	9.4	88.9	56.9
MSS	1.5	.9	1.1	-1.7	14.1	85.2	58.4
				Comparisons of *g* ("AUTRES")			
MGS	13.3	1.0[1]	2.04	-13.3			
MS	2.2	.06[2]	.44	-39.5	16.5	6.8	21.4
MGSS	9.3	.09[1]	1.32	-103.1	70.0	9.1	64.9
MSS	2.8	.10[3]	.73	-28.0	21.0	-	35.[illegible]

---

(1) The highest level where *g* applies is the 400 level.
(2) The highest level where *g* applies is the 300 level.
(3) *g* applies right up to the 700 level.

We remind the reader that these figures are averages per FIU. Normally we should not expect there to be less than 1 group, because as a unit a group is a group. At some FIU levels, some FIUs use no "AUTRES". Therefore, there may be less than one group per FIU on the average at these levels. In no case can the sum of groups for professors and "AUTRES" together be less than one per FIU at any level; between the two categories of staff, they must staff each FIU, of which there must be at least one group. We have no staffless FIUs.

As we have already tabulated the data for Pe in T-2, we simply reproduce it here:

Comparison of Pe

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
IDEN	100 lev. hrs.	HIGH lev. hrs.	AVR hrs.	D		INTER	
					100 lev	HIGH	AVR
MGS	152.58	63.04	103.43	-2.4	97.5	47.2	97.1
MS	148.86	29.77	100.39	-5.0	54.2	74.0	75.3
MGSS	82.71	28.91	77.87	-2.9	41.3	57.4	49.7
MSS	63.04	49.59	51.42	-2.4			

(i) Comparison by Level:

We discuss professors, then "AUTRES". In all four departments, average Te per FIU decreases with FIU level. (See T-4). This means that the combination of (Pe . g) falls with FIU level. In all four departments, both Pe and g fall with increased FIU levels. As we mentioned in T-2 above, the fall in Pe occurs because students have fewer labs and tutorials at the upper FIU levels. An examination of Appendix IV, Table A, would also reveal that the duration and the number of sessions per week of graduate FIUs tends on the whole to be lower than at the introductory levels. We have not computed average values for each component of Pe because we believe that the point is quite obvious from casual examination of the data.

The decrease in g by level depends upon the relationship between total enrolment and class size. We have examined enrolment figures in T-3, and reproduce them here, along with those for z.

Comparisons of "e"

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
IDEN	100 lev	HIGH lev	AVR	D		INTER	
	#	#	#		100 lev	HIGH	AVR
MCS	484.6	21.5	77.4	-22.5			
MS	185.9	6.7	52.4	-27.8	38.35	31.0	67.8**
MGSS	198.4	8.4	45.4	-23.7	40.93	51.9	58.6**
MSS	133.3	7.0	44.9	-19.0	27.51	48.12	58.0

TABLE T - 5 (a)

Comparisons of "z" (Professors)

MGS	92.6	21.5	51.0	- 4.3			
MS	139.53	6.7	44.5	-21.0	150.6	31.1	87.2
MGSS	184.17	8.4	38.5	-22.0	198.8	52.1	75.6
MSS	96.25	6.3	36.0	-15.3	103.9	45.4	70.7

** Intermediate levels had higher indices than the highest level.

Comparing column 5 for e and for z, we notice that the rate of decrease in e is consistently higher than the rate of decrease in z. Therefore, the rate of decrease of e/z must be less than the rate of decrease of e alone, or in other words, the number of groups falls less than proportionately to enrolment. This is a normal expectation, because class size (z) cannot exceed enrolment, it may be less than enrolment, but in many FIUs enrolments are not large enough to warrant splitting the total into smaller classes. This is particularly true at the upper level FIUs, where the number of groups is generally no more than one.

The same happens with regard to "AUTRES", but more radically.

TABLE T - 5 (b)

Comparisons of "z" ("AUTRES")

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
IDEN	100 lev	HIGH lev.	AVR	D		INTER	
					100 lev	HIGH	AVR
MGS	19.3	.89[1]	3.86	-21.6			
MS	38.4	2.67[1]	10.73	-14.4	198.6	298.	278.1
MGSS	29.0	1.0 [1]	6.28	-28.9	150.0	111.8	162.9
MSS	23.6	.7 [2]	5.72	-33.8	122.3	-	148.3

---

(1) Applies only up to and including the 400 level.
(2) Applies up to and including the 700 level.

The rate of decrease in x is much higher for "AUTRES" than for professors. This happens largely because the departments make less use of "AUTRES" as level increases. Combined with the increasing quantities of FIUs over which their use is averaged, their rates of decrease on the average per FIU are considerably greater.

In sum, for professors, the average number of groups per FIU falls with increasing FIU levels because there is a minimum below which splitting enrolments into different groups is unnecessary, and enrolment at the higher FIU levels generally conforms to this (variable) minimum.

Comparing e to g (T-5 and page 260) at different levels in different departments: in McGill Science, when average e per FIU reaches 19-20 students, g is only very slightly above one. In Montreal Science, when e reaches approximately seven students, g is one. In McGill Social Science, g is one from 198 students downward. In Montreal Social Science g is generally one or less from 75 students downward, with the exception of the 400 level. Montreal Science's pronounced decrease in Ta from the lowest to the highest FIU level happened more because of the decrease in Pe (-5.0) than the decrease in g (-2.8). There are interesting interdisciplinary differences to which we turn.

(ii) Comparison by Discipline:

We saw in Table T-4 (g) that Ta in science is 158.9% of Ta in social science. We examine the relative values of Pe and g to see whether student hour requirements or grouping made the most difference between the disciplines:

TABLE T - 5 (c)

Mean of Means by Discipline

	Pe	g
Science	3.7	1.5
Social Science	2.65	1.1
Science/Social Science	139.6	136.3

It turns out that science required both more hours and more groups to handle its programs than social science, and the relative rates of increase are very close. We suggest that this phenomenon occurs for different reasons in the two science departments. In McGill Science, more professorial hours and more groups are required than in social science because professors handle tutorials. In Montreal Science, the reason is that professors attend labs. In the social science departments, "AUTRES" normally handle the tutorials. Generally the group size (*z*) is lower for lab and tutorial activity than it is for lecture activity. This is evident from the differences in average *z* per FIU (T-5 (a)). for professors compared to those for "AUTRES" (T-5 (b)). It may also be observed by examining the values of z_1 and z_2 for professors in tutorial and lab activity as they appear in Appendix IV, Table A.

In T-4 (i) we noted that the mean of decreases in *Ta* by discipline from the lowest to the highest FIU level is much higher for science than for social science, science's drop in *Ta* being 353.3% of that in social science. We examine the mean of changes by discipline in an attempt to discover whether it happens more on account of falling *Pe* or of falling *g*.

TABLE T - 5 (d)

Mean of Changes by Discipline (Professors)

	Pe	g
Science	- 3.7	- 6.15
Social Science	- 2.65	- 1.35
Science/Social Science	-139.6	455.5

The relative decrease in groups to Pe was higher in science than in social science: while science groups decreased by 455.5% of social science groups, science Pe decreased only 139.6% of social science Pe. This occurs because the science departments start on a larger base (given professorial commitments to labs and tutorials) which becomes very small as labs and tutorials almost disappear at the higher FIU levels. In Social Science, the base number of groups is smaller because professors do not generally teach labs and tutorials. Since they do not teach them at upper levels either, and since lecture or seminar activity varies less with FIU level than lab and tutorial activity, the average number of groups per FIU in social science is bound to change less. In other words, in science, professors do activities which require more groups than the activities which social science professors do, however, unlike in the social sciences, the existence of the science activities which professors do, relates negatively with increased FIU level, thereby causing a greater relative decrease in group requirements.

Since the mean of mean change in Ta differed little between McGill and Montreal, we do not examine inter-university composition of Pe and g.

SYNTHESIS:

We present a general view of how the elements contributing to average C per FIU influenced relative magnitudes of average C by level, by discipline and by university. The values apply to professors.

(1) In general, C decreases as level increases. This occurs because:

(a) Pe, g, and Ta decrease from the lowest to the highest FIU level.

(b) CH generally increases with FIU level, but not enough to offset the negative influence of the decrease in Ta. The increases in CH occur because SA increases. In two cases increases in x mitigate the increases in SA.

(2) In general, Science C is higher than Social Science C: This occurs because:

(a) Ta, Pe and g are generally higher in science than in social science.

(b) CH in science is somewhat lower than CH in social science, but not sufficiently lower to offset the higher Ta. Science SA is higher than social science SA, however, science x is proportionately higher than social science x, resulting in the comparatively lower science CH.

(3) In general, McGill C is higher than Montreal C:

This occurs because:

(a) McGill Ta is slightly higher than Montreal Ta.

(b) McGill CH is slightly higher than Montreal CH.

When the relative behaviour of C is viewed in conjunction with enrolment (e) and the influence of Pe is netted out of the average, we find that in general:

(4) A decreases with FIU level by more than C largely because enrolment decreases by more than total cost.

(5) Social Science A is higher than Science A despite Social Science C being lower than Science C, largely because e in social science is less than that of science.

(6) McGill A is lower than Montreal A, despite the fact that McGill C is higher than Montreal C, largely because

McGill e is greater than Montreal e. Or, despite its higher absolute cost level, McGill "processes" more students per dollar than does Montreal.

One of the implications of this investigation is that the easiest way to achieve lower costs per student is to increase student numbers more than proportionately to total cost. Though we have no time series data, we believe that a time series investigation with the use of our accounting framework would reveal this trend. Students have expressed considerable dissatisfaction with this arrangement, and it does not seem to be a very feasible solution, particularly at the higher FIU levels where A per FIU is highest. We turn to an examination of novel pedagogic methods which attempt to improve learning at reduced cost. The two situations we examine, one hypothetical, the other real, have in common a concerted effort to rationalize the use of Ta (professors) and to reduce CH, while handling large enrolments.

IV. PROGRAM PLANNING

The importance of any costing device such as this accounting framework lies in its ability to answer questions about what happens to costs when teaching structures and systems change. If the framework is "culture-bound" to the extent that it can only define the status quo with more precision than now maintains, we would consider the effort nearly useless. One of the more important reasons we have articulated teaching organization to the level of the individual activity is to create the sort of flexibility that comes with disaggregation down to the "atomic state". Our "atoms" may be defined to consist of whatever activities describe a new teaching format, and the atoms may be combined with one another to assemble a global picture of a new structure. Each element of cost associated with these new activities may be attributed to the respective activities depending upon our ability to identify input-output relationships no more unsatisfactorily than we are able to do with present structures. Hopefully, we would obtain comparable cost information and we may begin to settle arguments with facts. It is often heard that costs constrain innovation, or that different formats are necessarily more expensive than existing ones unless they involve a high degree of automation. These arguments are seldom supported by carefully prepared evidence. They may or may not be true. We would like to remove this uncertainty from the discussion.

One difficult area of uncertainty to resolve is that of cost/output comparison. In a sense, comparing the cost of one educational output with another is like the use of a price index to measure inflation. In the latter case, the basket of goods is assumed unchanged, and relative changes in its value is supposed to yield a measure of inflation. We know that baskets do not remain the same either in quality or composition, so that the index is not an ideal measure of inflation by any means.[1] Similarly in education, when the teaching format and techniques change, the quality of the output may change as well. Relative cost statements may not be informing on similar outputs. Of course, we would like our measure of the changes in output to be as precise as possible—be it qualitative or quantitative—so that when the costs are compared, they will be accompanied by an assessment of the anticipated benefits of one design over another. We suggest that it is not satisfactory to make decisions on the basis of cost data alone, even though it is obviously necessary to consider for whatever structural reforms the system may envisage.

---

[1] Asimakopulos, A., "The Consumer Price Index", The Canadian Journal of Economics and Political Science, August 1963.

To test the flexibility of the accounting framework, we have selected a proposal for a very different format of teaching than now maintains in any Quebec university to our knowledge. The system was designed by Mr. Donald Kingsbury of the Mathematics Department of McGill University. We reproduce Mr. Kingsbury's description of his proposal in Appendix I.

A distinguishing feature of the Math Learning Centre (MLC) is that it dispenses with lectures, and replaces them with self-study packages of learning materials. Each package contains references, instructions, problems and a test relevant to the concepts the student wishes to master.

Students come to the MLC and request packages, either in isolation or in a series. What they request depends upon the kind of mathematics training they require and what they already know. A year's program consists of those packages which the student needs. Every student may have a different program. In many cases one package can enter into many programs, while in some cases, packages may be tailor-made for very specific requirements.

The mechanics of the system work as follows:

Firstly, the student comes for a general consultation to establish his package requirements and approximate rate of anticipated progress.

Secondly, the student uses the package materials. If he has trouble, he brings his problem to a consultant who lends assistance and files a report on the problem in the package file.

Thirdly, the student offers himself for testing. A tester marks the test, and a consultant discusses the results with the student. If the student passes, this is noted in his transcript.

A design team designs the packages and refines them in light of two kinds of information: firstly, the problems that the students encounter, and secondly from indications about the quality of the package assessed by analysis of test answers.

From this description of the Math Learning Centre, we describe two models of the Kingsbury system. In Model One, 100 students each complete 26 packages. Since packages have an average duration of one week, the output is 2600 student-packages. In terms of student time, Model One is roughly comparable to a full course in the lecture system. Model Two departs from Model One in its assumption that not all students need 26 packages per annum, but something less. This assumption is consistent with a feature that Mr. Kingsbury claims to favour his system: it eliminates unnecessary instruction (relative to student requirements) because the program is flexible.

We illustrate the mechanics of the accounts for each of the four activities in Model One, and describe the underlying behavioural hypotheses. The accounting data able V

Comparative Accounts - Math Learning Centre and Lecture System

		1 a	2 b	3 d	4 f	5 h	6 e	7 s'	8	9 S	10 Tb	11 Ta	12 l	13 B	14 n	15 β	16 pt.	17 c	18 CU	19 CR
A.	**MATH LEARNING CENTRE**																			
1.	General Consultation for	1	1	.3		1 .3	60		1	60	30	30	-	consult	156	1560	.192	290.33	4.09(1)	10.00
2.	Requirements, Timetable etc.	1	1	.3		3 1.5	30		1	30	65	65	-	consult	156	1560	.208	449.28	14.97	10.00
3.		2 26	.3	.3		1 .3	10		1	10	5	65	-	consult	156	1560	.416	448.96	64.89	10.00
4.	TOTAL						100					140					.896	1397.76	13.98	10.20
5.	Package "a"	1	1				100													
6.	Consultation (Hang-ups)	1	1	.17		1 .17	20		1	20	3.4	3.4	-	consult	156	1560	.072	34.32	1.72	10.00
7.				.17		2 .34	10		1	10	3.4	3.4	-	consult	156	1560	.022	34.32	3.44	10.00
8.				.33		1 .33	5		1	5	1.7	1.7	-	consult	156	1560	.011	17.16	3.44	10.00
9.						8	65					8.5					[illegible]	85.90	.84	10.00
10.	ST.						100													
		1	1	.10		1 .10	65		1	65	6.5	6.5	-	tester	156	936	[illegible]	[illegible]	[illegible]	6.00
11.	Testing (By Hand)					2 .20	30		1	30	6.0	6.0	-	tester	156	936	.016	33.37	1.19(1)	6.00
12.						3 .30	5		1	5	1.5	1.5	-	tester	156	936	.010	9.36	1.03(1)	6.00
13.							100					14.0					.040	84.24	.84	6.00
14.	ST.											2	1234		2 1040	13 000	.061	30.08	.30	14.42
15.	Design— Original	-	-	-		- -	-		-	-	-	5	1234		2 1040	13 000	.005	71.00	.73	14.42
16.	Design— Refinement		-			-	-		-	-	-	7					.007	101.00	1.03	14.42
17.	ST.											29.3						275.04	2.75	9.18
18.	**Totals Package "a"**											76.7						2151.84	21.51	9.18
3.19.	Package "a" x 26 weeks											14.0						1397.76	13.98	10.00
20.	Add. Consultation Line 4											90.7						8548.80	85.49	9.31
21.	**Total 1+2**																			
B.	**LECTURE SYSTEM**																			
22.	Lectures	26	1		1	2 2	100		100.	1	2	32	1234		2 156	15000	.133	4993.00	49.95	96.03
23.	Tutorials	26	1		1	1 1	100		25	4	4	104	tut		1	25	104	[illegible].00	26.00	25.00
24.	Totals											136						7593.00	75.95	48.69

* Col. 8 is irrelevant to Math Students.

(1) [illegible]

is in Table V . To calculate the costs associated with Model Two, we make several simplifying assumptions and calculate the resulting differences between the two models.

A. Math Learning Centre: (x/y = line/col.) total enrolment:
Model One 100 students.

Activity 1: The students come for general consultation regarding their requirements and the timetabling of their progress. Different students will have different needs in this respect, and we have made allowance for that in the accounting, because greater loads placed on consultants incur additional costs.

1/1,2 : The value of 1 is assigned to these boxes to neutralize their effect on the subsequent computations. They are irrelevant.

1/3,5 : We assume that a consultation with a student lasts an average of ½ an hour.

1/4,6 : 60 of the 100 students have one consultation for the year and require no more timetabling or program-structure guidance than that.

1/7 : Guidance activity is held with one student at a time.

1/9 : This produces as many "groups" as there are students to be guided.

1/10,11 : The required number of hours to handle these students is 30.

1/13 : A consultant (graduate student) handles the guidance.

1/14 : The consultant has an annual work load of 156 contact hours per academic year with the students. (6 hrs./wk. x 26 weeks).

1/15 : He is paid a salary of $1,560 for the year.

1/16 : The fraction of his time needed for this activity is .192.

1/17 : This generates a cost of $299.52.

1/18 : The cost for each of the 60 students is $4.99.*

1/19 : The cost per hour of the consultant's time is $10.00.

Line 2 repeats the same sort of calculation for the same activity, the only difference being that:

---

* Theoretically, $5.00. There is a small rounding error.

2/4,6 : Thirty students require three of these consulting sessions during the year because they are less self-sufficient than the previous 60.

Line 3 repeats the same sort of calculation for the same activity, however this time we are dealing with a hard core of dependent souls who need relatively regular surveillance to make sure they are performing on schedule. We give them regularity by assuming:

3/1 : The guidance activity is spread over 26 weeks.

3/2 : Guidance occurs every two weeks.

3/3 : Each guidance session lasts one half hour.

3/4 : The student comes once every two weeks.

3/5 : Hours on guidance per student = $\frac{1}{2}$.

3/6 : Ten students are involved in this exercise.

The remaining inputs are the same as above and the output calculated in the usual way.

4/6 : We have accounted for the consultation pattern of all 100 students.

4/16 : We need 9/10 of a consultant to carry the total load.

4/11 : 140 hours of consulting are required overall.

4/17 : The total cost of this consulting is $1397.76, assuming that the other 1/10 of his time will be committed to another activity.

4/18 : The overall average cost per student is $13.98.

4/19 : The cost per hour of consultant's time is $10.00.

From a low of $4.99 for one guidance session per year, we reach a high of $64.89 for the dependent souls. The value of $13.98 in box 4/18 is a weighted average for the 100 students. Clearly, the more self-sufficiency the MLC can infuse in the 2nd and 3rd category of students, the lower will be the average consulting cost. A financial advantage of the system is that it has the kind of flexibility which makes cost a negative function of self-sufficiency. The lecture system is insensitive (cost-wise) to this factor, because course loads are probably not tied in any explicit way to the amount of time the professor anticipates visits from troubled students.

The importance of guidance as a distinct activity in the MLC is that it determines the student's program for the year, as well as his rate of progress through it. In the lecture system, the program length and content are pre-determined by the calendar; it is not an instructional variable and need not consume staff time.

After finishing his consulting, as described by Activity One, the student collects whichever packages he requires and goes to work. We articulate the costs associated with this activity, assuming as usual that student time is a free good. In effect we are calculating cost to the university.

Activity 2: Package "a":

In this section we simulate a hypothetical cost structure that may be associated with a "typical" package. We use the concept of the typical package to simplify the amount of simulation to be done. We assume that if the technique is valid for one package, it should be the same for any other. Only values may differ. This assumption is valid as long as we hold technology constant from one package to the other.

We operate on Mr. Kingsbury's hypothesis that the student should complete the typical package within one week at the most. A program for 100 students over 26 weeks will therefore consist of 2600 "student-packages". This is the "equivalent" of a full course. We account on this assumption for purposes of building a basis of comparison between two bundles of goods that are as comparable as possible. Thus, for now, we describe the behaviour and costs associated with one package, and multiply it by 26 to derive a full program cost estimate. We will drop the assumption of chronological equivalence at the end of the exercise, in keeping with the structural philosophy of the MLC.

The package activity contains several sub-activities:

(1) consulting about hang-ups

(2) testing

(3) package design

(4) package refinement

(1) Consultation about hang-ups: (lines 5-10)

When students work on the package, different students will have different amounts and types of hang-ups. The quantity of these hang-ups depends on the quality of both the student and the package.

Our accounting framework allows us to tabulate a distribution of students by frequency of hang-ups. This is important because costs are positively associated with consultation for hang-ups.

We describe consulation as follows:

5/1,2 : The package is done once, weekly.

5/6 : A total of 100 students do the package.

6/1,2 : Not applicable.

6/3,5 : The consultation lasts on the average 10 minutes, i.e., .17 hours.

6/4,6 : 20 students will have one hang-up consultation.

6/7 : Consultations are individual.

6/9 : This generates 20 "groups".

6/10,11: The total requirement for this pattern of consultation is 3.4 hours.

6/13 : The staff is a consultant (graduate student).

6/14 : His workload is 156 contact hours per academic year.

6/.5 : He is paid $1560 for the year.

6/16 : The fraction of his time required for this activity is .022.

6/17 : The total cost is $34.32.

6/18 : The unit cost for each of the 20 students is $1.72.

6/19 : The cost per hour of the consultant's time is $10.00.

Line 7 repeats the same sort of calculation for the same activity, the only difference being that:

7/4,6 : 10 students require two hang-up consultations for the package.

Line 8, in turn specifies that:

8/3 : These hang-ups are more serious and take .33 hours to discuss, or 20 minutes.

8/4,6 : 5 students each have 1 hang-up of this kind.

The output calculation in lines 7 and 8 follow the usual procedure, producing new values on account of the change in input information. Line 9 tells us that 65 students had no hang-ups. This may imply a reasonably good package and good group of students. Summary information is provided by:

10/6 : Hang-up activity of 100 students is accounted.

10/11 : Hang-up consultations required a total of 8.5 contact hours.

10/16 : This requires .055 consultants.

10/17 : The total cost of consulting is $85.80.

10/18 : The weighted average cost per student for 100 students is $.86.

10/19 : The cost per hour of consultation is $10.00.

The value of the weighted average cost per student would increase with increased consulting requirements due to increased length of consultation, increased frequency of consultation per student, or increased numbers of students requiring consultation. Clearly the better the package is designed and the brighter the students, the cheaper consultation will be over the total enrolment.

Since student feedback is an essential element in the structure of the package, it will require some design and feedback experience before the MLC has sufficient data to make the marginal economic calculation between spending additional time on design, as opposed to releasing the package in its given state for student use. For example, according to our hypothetical data, design and refinement hours are each worth $14.42. Consultation hours are worth $10.00 each. Suppose the designers have reached a point where they feel that they may improve the package with one more hour of design, yielding an additional cost of $14.42. They also know that student feedback improves the efficiency of design because the student may find where he has trouble quicker than the design team may anticipate it without prior information. They release the package. In so doing, it contains one source of difficulty that an additional hour of design would have eliminated. The first student who encounters the problem consumes 10 minutes of consultation time at a cost of $1.72; because the trouble is located, refinement requires only one half hour at a cost of $7.21. The MLC spends $8.93 to refine the package via the student, rather than $14.42 before it reaches the student. In this way the MLC saves $5.49. Marginal calculations of this kind would require considerable experience on the part of the design team.

(2) Testing: (lines 11-14)

After students complete the package, they present themselves for a test. We have assumed for the sake of simplicity that no computers are involved in testing at this stage of development. Different students will perform differently on tests. Since the system is "pass-fail", any student who fails has no record for completion of the package and may have himself re-tested. We have assumed that all tests require, on the average, the same amount of time for the tester to mark and diagnose. We could remove this assumption without invalidating the use of the accounting framework to describe testing. It would merely involve adding as many lines to the accounts as there are tests of different length to mark and diagnose.

We illustrate with a distribution of students who require varying numbers of tests on the same package. The accounts inform us:

11/1,2 : Not applicable.
11/3 : It takes 6 minutes or .10 hours to mark and diagnose a test.
11/4,6 : 65 students go for one test on the package.
11/5 : The time required per student to mark and diagnose a test is 6 minutes.
11/7 : Each student's test is graded individually.
11/9 : This produces 65 "groups" for grading.
11/10,11: 3.4 hours are needed to do this grading.
11/13 : Grading is done by a tester (graduate student).
11/14 : Each tester has a work load of 156 hours per annum.
11/15 : Testers are paid $936 per annum.

11/16 : .042 testers are required for this activity.

11/17 : The total cost is $39.31.

11/18 : The cost per student for the 65 students is $.60.

11/19 : The cost per hour for a tester is $6.00.

Line 12 repeats the same operation, the only difference in input information being:

12/4,6 : 30 students require two tests for the package.

Similarly in line 13, the difference in input information is that:

13/4,6 : 5 students must be tested 3 times over.

Summarizing the information on testing:

14/6 ; The testing of 100 students is accounted for.

14/11 : Total number of hours required for testing is 14.

14/16 : The activity requires .09 testers.

14/17 : The total cost for testing is $84.24.

14/18 : The weighted average cost per student is $.84.

14/19 : The cost per hour of testers is $6.00.

The weighted average cost per student for testing would decrease to a minimum of $.60 per student as the need for re-testing tends toward zero. It pays the department not to have to re-test. It may or may not pay the student. If students wait an inordinate amount of time before presenting themselves for a test, their progress may be slowed. The student will have to make a marginal calculation to decide what additional amount of preparation he is prepared to sacrifice in order to risk the test. As much as it is financially advisable for the MLC to encourage students to present themselves for testing when they are well prepared, it should also try to ensure that students do not behave over-cautiously.

(3) Original Package Design: (line 15.)

Columns 1-10 of the accounting framework are not relevant to the description of this activity, because it is not the sort of activity which can be described in terms of student numbers carrying out certain routines according to a generally predictable time sequence.

Package design is a capital investment. In our current accounting framework we suggest the capital cost of designing a package, its rate of depreciation, and record the value of annual depreciation. We note several difficulties involved in this procedure.

Firstly, the amount of time required to design packages may be highly variable from one package to the next, and it may be difficult to estimate this factor accurately in advance. When the designers acquire some experience at work, observation of past performance would be useful to incorporate in future plans.

Secondly, the useful life of a package is difficult to estimate. This depends upon the rate at which both the concepts and the ways of imparting them become obsolete. Some packages may have a very long life, others much less. We suggest that packages which convey basic concepts would probably have a long life span, however, their structure may undergo substantial revision from year to year.

The process of revision we call "package refinement", and since this activity presumably carries on from one year to the next, we include all annual package refinement costs in current account. It would be useful to observe whether the amount of refinement in the first time period bears any relationship to the amount required in later time periods.

Using hypothetical estimates, we make the following projections in the description of package design:

15/11 : It takes twenty hours to design the package, or two "current"hours assuming a rate of depreciation of 10% per annum for 10 years.

15/12 : The work is done by Mr. 1234.

15/13 : His rank is "associate professor".

15/14 : His work load on designing is 1040 hours per annum (calculated on the basis of a "normal" 40 hour work week for 26 weeks).

15/15 : His annual salary is 15,000 dollars.

15/16 : Designing this package requires .02 designers.

15/17 : The total cost is $300.00, yielding an annual average depreciated value of $30.00.

15/18 : The cost per student is $30.00.

15/19 : One hour of the designer's time costs $14.42.

(4) Package Refinement: (line 16).

The accounting is the same as that described for package design, however, we have assumed 5 hours of refinement activity, no depreciation, and the outputs change correspondingly.

In summary:

17/11 : We expect package design and refinement to consume 7 current hours.

17/16 : It requires .007 current designers.

17/17 : The cost is $105.00.

17/18 : The cost per student is $1.05.

17/19 : The cost per hour for the designer is $14.42.

In line 18 we summarize costs and workloads involved in package "a". The figures are the sum of the subtotals of lines 10, 14 and 17:

18/11 : A total of 29.5 hours is consumed in the preparation and use of the package.

18/17 : The total cost of the activity is $275.04

18/18 : The unit cost per student is $2.75.

18/19 : The weighted average cost per hour of time involved is $9.18.

In line 19, we multiply these results by 26 to simulate the cost per academic year, in line with our original assumption that package "a" is "typical". We learn that:

19/11 : 767 hours of time are involved.
19/17 : The annual cost is $7151.04.
19/18 : The average annual cost per student is $71.51.

In line 20, we add to these annual cost figures, the annual cost of guidance and scheduling consultation (Activity 1), the figures for which are simply brought down from line 4.

In line 21, we read the total annual workload and cost involved in the administration of general guidance plus 2600 student-packages:

21/11 : The total effort consumes 907 hours.
21/17 : The total annual cost is $8548.80.
21/18 : The average annual cost per student is $85.49.
21/19 : The weighted average annual cost per hour is $9.31.

We now compare these estimates with those of running a 26 week lecture course to 100 students. We will then discuss the input hypotheses for both systems in more detail.

With regard to the lecture course, line 22 describes lecture activity:

22/1 : Lectures cover a 26 week period.
22/2 : They occur weekly.
22/3 : Each lecture lasts 1 hour.
22/4 : Each student attends 2 lectures per week.
22/5 : Each student attends two hours of lectures per week.
22/6 : Lecture enrollment is 100 students.
22/7 : All 100 students attend lectures at the same time.
22/9 : This yields one group.
22/10 : Therefore 2 hours of lecturing per week are required.
22/11 : 52 hours per annum are required.
22/12 : Lectures are given by Mr. 1234.
22/13 : Mr. 1234 is an associate professor.
22/14 : His annual workload is 156 contact hours.
22/15 : His annual salary is $15,000.
22/16 : This activity requires .333 of his time.
22/17 : The cost is $4995.00.
22/18 : The average cost per student is $49.95.
22/19 : Cost per contact hour is $96.05.

The course also has a tutorial described in line 23:

23/1 : Tutorials cover a 26 week period.

23/2 : They occur weekly.

23/3 : Each tutorial lasts one hour.

23/4 : Each student goes to 1 tutorial.

23/5 : Each student has one hour of tutorial per week.

23/6 : 100 students attend the tutorials.

23/7 : 25 attend tutorials at one time.

23/9 : This yields 4 groups.

23/10 : Therefore 4 hours of tutorial are required per week.

23/11 : 104 hours of tutorials are required per academic year.

23/12 : The tutorials are given by a tutor.

23/14 : The tutor is paid hourly and,

23/15 : His rate of pay is $25.00 per hour.

23/16 : 104 hours of his time are required.

23/17 : The total cost of this time is $2600.

23/18 : Unit cost per student is $26.00.

In summary:

24/11 : A total of 156 hours are required for the course.

24/17 : The total cost is $7595.

24/18 : The average annual cost per student is $75.95.

24/19 : The weighted average annual cost per hour is $48.69.

In the following Table we summarize the comparative costs and benefits of the alternative systems;

COMPARATIVE COST-BENEFIT SCHEDULE

RESOURCE LOADS AND ASSOCIATED COSTS	MLC	LECTURE SYST
1. Total workload	907 hours	156 hours
2. Professorial time	182 hrs. (7/pge x 26 wks)	52 hours
3. Other instructors	725 hrs. (907 - 182)	104 hours
4. Ratio 2/3	.25	.5
5. Total cost	$8548.80	$7595.00
6. Average cost/student	$85.49	$ 75.95
7. Weighted average cost/hour	$ 9.31	$ 48.69
BENEFITS*		
1.		slightly cheaper
2.	paced to individual needs	
3.	individual attention where needed	some studen get individ attention
4.	valuable training for instructors	
5.	credit recorded according to conceptual accomplishment rather than according to numbers that inform on competence with much less precision.	
6.	competence standards and test procedure positively reinforce motivation	
7.	students only credited for competence, not partial incompetence	some students develop compet
8.	efficiency of learning materials maximized by constant feed-back and re-design	
9.	learning materials may be publishable with royalties.	

---

* All according to Mr. Kingsbury. The cost analyst has no studied aspect of the evaluation.

Several comments on the interpretation of this data are in order. Since these have to do with the assumptions about costs and workloads, we discuss these at the same time.

The comparison that immediately comes to mind is that of total workloads. At first glance, 907 hours versus 156 hours makes the MLC appear to be a very labour intensive enterprise, relative to the lecture system. The comparison is not entirely fair, because the workloads subsumed under these figures are differently defined, consistent with the differing nature of the activities involved.

With regard to the MLC guidance and scheduling consultation (Activity 1), the half-hour workload per student per consultation is mainly all contact time that has no more background preparation time involved than recording the essentials of the meeting and having it filed by secretarial staff.

With regard to MLC package "a" (Activity 2), hang-up consultation time (as recorded in boxes 6,7,8,/3) is a sum that includes contact with the student as well as the time needed to scribble a report for filing in the hang-up file. We recorded it in this way because filing the report is an explicit responsibility of the consultant which is done regularly with each consultation. We wish the workload figure to be inclusive because it is important for assessing the number of consultants required and the basis on which they will be paid.

Testing time is not an activity which involves contact hour measurement with students unless the test is oral. We have assumed written tests in this example, though we could change this to oral ones with no fatal difficulty. The time alloted for the correction of each test includes the preparation of the diagnosis. We record the time involved for both activities together, again because the diagnosis is required for every wrong answer, and it is an explicit responsibility of the tester which he executes with the marking of each test. We wish the workload figure to be inclusive for purposes of determining total time commitment of graduate students, the numbers needed and their pay basis.

Design and refinement time is not amenable to contact hour treatment because it involves no contact hours. We have assumed that full-time design staff works on design and refinement. If the argument of 40/hours per week for 26 weeks (or 1040 hours per annum) and the estimate of current hours for design and refinement of a package is queried because they require time-motion measurement procedures that staff may find objectionable, then we could just as easily plan on the hypothesis of a production rate (in this case) of 41 packages and refinements per annum per staff member and the current cost per package would be the same. This is a result of dividing 1040 working hours per academic year by 25 current hours per design and refinement of a package. We used the time projections rather than unit product projections to be consistent in our use of the accounting framework. As long as the two are consistent with what we may expect in reality, it makes no theoretical difference whether the projection norm is counted in hours per unit or units per academic year. An important point to retain in this discussion is that the time quotation for design and refinement implies no other background activity.

Two generalizations are in order for all time estimates used in the activity descriptions for the Math Learning Centre:

(1) They are not based on fact. The MLC is non-existent at time of writing, therefore, we are making what seem to be reasonable estimates, based on intuitive consideration of the kind of work involved.

(2) They are time commitments that imply little or no background activity. This is distinctly contradictory to the procedure employed for measuring time in the lecture system, where contact hours serve as a proxy for all the background work that goes into the preparation of lectures, tutorials, setting and marking of tests, interviewing the occasional student and all other academic administration relevant to the course and handled by the professor and tutor.

In sum, the fact that MLC workloads are explicit on all time commitments, and the lecture system workloads account contact hours only (which serves as a proxy for all other time) means that the total number of comparable hours of work associated with the activity will not differ to the extent of 907 vs 156.

We note that the total annual contact hour workload of professor 1234 in the lecture system is a "common workload" that involves 6 contact hours per week for a 26 week academic year.

Line 4 of the cost-benefit table indicates that the re
tive use of professorial and teaching assistant time in each sys
It shows that of its total resource commitment to the program,

the MLC uses 25% expensive professonal manpower, while the lecture system uses 50%. Of course, the extent to which the MLC is more *efficient* in its use of professorial time does not hinge on the simple fact that its use ratio is lower. The lowness of this ratio is efficient only to the extent that it is pedagogically unnecessary for it to be any higher.

Line 5 of the cost benefit table informs that the MLC course costs a total of $8548.80, compared to $7595.00 for the lecture system. Various salary hypotheses contribute to this result.

With regard to professorial services, we have assumed that where each system uses them, the annual rate of pay is the same. We have chosen a figure of $15,000.00 which is a salary that an associate professor could expect to earn, in Quebec in 1969. Each is normally loaded, on the assumption that six contact hours per week over 26 weeks constitute a normal teaching load for a member of academic staff in the lecture system, while the "same man" can be expected to design and refine 41 packages in 26 weeks in the MLC. Both may have other commitments, such as thesis supervision, committee work, some administration and community service. In neither case is it explicitly counted. We attribute pay to teaching on the basis of measurable workloads defined consistently with the system at hand. The pay basis of the non-professorial staff differs somewhat more between the two systems. While the consultants and testers in the MLC earn $10.00 and $6.00 per hour respectively, we have assigned a rate of $25.00 per hour for teaching assistants in the lecture system. While the relative awards may seem discriminatory at first glance, we have reason to believe that there is actually little injustice. The $25.00 per contact hour earned by the teaching assistant in the lecture system is a proxy fee for administration, correction, assistance in setting exams, interviewing students, as well as the preparation and delivery of four tutorials per week. We have chosen this combination of rate and responsibilities from a situation that actually maintained in one department of one large Montreal university. The pay worked out to a $2500.00 assistantship for teaching four tutorial groups per week per academic year. The consultants and testers in the MLC have no other responsibilities than those for which they are explicitly paid. That is why we have set lower hourly rates for the jobs described. In the lecture system an hour is really more than an hour The choice of rates for consulting and testing activity in the

MLC are not completely random. They correspond to what one large university in Montreal pays graduate students for teaching an hour of tutorial (with no other side responsibility) or for correcting examinations. The pay rate for exam correction may be based on a rate per paper, or on an hourly basis. It makes no theoretical difference as long as the number of papers corrected per hour divided into the hourly rate works out to the rate per paper that the department would have to pay to attract the necessary services.

In discussing these pay rates and workloads, we emphasize the fact that the MLC has yet to exist, thus there may be a difference between the hypothetical notions suggested here and real experience in attracting competent services to the MLC. While our hypotheses are not entirely random, they may or may not be close to reality.

In this connection, there are several dynamic considerations that may influence wage rates. Firstly, generalization of the MLC system would generate considerable demand for testers and consultants and this may push wages up. Secondly, the wage differential between testers and consultants may be difficult to maintain if both occupations draw upon the same kind of personnel with similar preference functions regarding job classification and pay expectations.

Line 6 of the cost-benefit table relates the average cost per student, and line 7, the weighted average cost per hour. The latter figure is much lower for the MLC because of its lower utilization rate of professorial staff (line 4), the lower valuation per hour of its services (achieved by the different way in which an hour of service is defined between the two systems) and the lower rate per hour paid to non-professorial staff, for reasons described above. This figure is probably less useful for purposes of comparison than the total or average cost per student figures. While the average cost per student figure represents an anticipated or actual disbursement, the average cost per hour figure averages amounts that are not strictly comparable due to differences in what the numbers within the average represent.

The exercise the cost-benefit table now invites, is to compare the additional cost of $9.54 per student in the MLC to the benefits that the MLC is supposed to confer relative to the lecture system. The benefits of the MLC, like its costs, are anticipated. They are the factors which motivated its design. Our cost-benefit analysis stops at this point. It does not indicate a decision either for or against the MLC. It has merely informed the decision by providing a coherent, roughly comparable basis of comparison of costs between the two systems which are conceptually different.

Rational decision-making procedures imply that decision-making criteria should first be explicit. The relative cost/benefits of the two systems may then be compared with the criteria so that decision makers may then choose in a manner consistent with their premises.

A difficulty involved in the cost/benefit analysis is that of measuring the benefits of the MLC over the lecture system. The question is: how do MLC graduates perform in the remainder of their careers compared to those of the lecture system?

There are different levels at which the benefits may be measured. Firstly, they may be measured at the scholastic level by assessing the extent to which MLC graduates are better or worse mathematicians than lecture system graduates. Secondly, were it possible to determine the extent to which mathematical competence matters to job acquisition and promotion, we could measure the "consumer surplus" achieved by the better math graduate, in terms of salary differentials between better and worse mathematicians over time. We hold out little hope for this line of inquiry because of the serious difficulties we may encounter in trying to isolate the effect of mathematical competence on employment advancement. Nonetheless, we may investigate the scholastic difference that MLC training makes, and then sample a number of mathematics students from both systems to see who gets the better-paying jobs, and whether scholastic achievement was a decisive factor.

Our cost analysis of the MLC is still incomplete. We have yet to drop the assumption that all students take 26 packages. It is important that we drop this assumption because it is fundamental to the mathetical approach of an enterprise such as the MLC that instruction be minimized to just the kind and amount that the individual needs.[30]

We remind the reader that in Model One, we have catered for 100 students taking one package per week for 26 weeks, yielding a total load of 2600 student-packages. It is quite likely that not all students require all of this instruction in their programs, and that resources may be economized by eliminating unnecessary activity. We illustrate one such possibility, making the following simplifying assumptions:

---

[30] What the student needs is determined by a process of analysis on the part of the learner and the instructors. This is established in the general consultation for scheduling and timetabling.

(1) No one student does more than 26 packages and not all do all 26 packages.

(2) Student numbers remain constant (100 students).

(3) For any number of students doing a number of packages, the rates of consultation and retesting are distributed proportionately to those of Model One.

(4) General guidance and consultation requirements (Activity 1) remain the same.

(5) Package refinement is invariate with respect to package use over the relevant range.

(6) There are no economies or diseconomies of scale.

Assumption (1) is the factor which distinguishes Model One from Model Two. Assumptions (2) and (3) are meant to preserve comparability with Model One. Assumptions (4) and (5) are not necessarily true. Removing them would require additional hypotheses about functional relationships which could maintain between package use, general consultation requirements and amount of package refinement. We have assumed these problems away to keep the model relatively simple. A subsequent model could be developed to incorporate these nuances with no fundamental change in the system. Assumption (6) keeps the problem linear, which is an easier mode of analysis than that imposed by a non-linear assumption. It may be a realistic assumption. That is a matter which is perhaps best approached empirically, as we have no *a priori* reason to believe that scale economies or diseconomies are involved in the range over which we are comparing outputs of Models One and Two.

We propose the following distribution of students by rate of package use. It is a hypothetical selection for illustrative purposes only.

Distribution of students by package use (Model Two)

Students (a)	use Packages (b):	Student-packages (a
10	26	260
50	16	800
20	12	240
20	5	100
Total 100		1400

(Consistent with assumption 1).

With these assumptions and the above distribution, we can make the following statements about costs and outputs:

(1) The total cost of Activity (1) of the MLC in the Accounts, "General Consultation for requirements" (box 4/17) remains the same, ($1397.76) in Model Two. (Assumption 4).

(2) The total cost of producing 26 packages and refining them is 26 packages multiplied by the $105 (Accounts box 17/17) required to produce 1 package. This yields a total of $2730. (Assumption 5).

(3) The output of package use was 2600 student-packages in Model One, but it is only 1400 student-packages in Model Two. (See distribution chart above).

(4) In Model One, the difference in Total Cost between package design and refinement ($2626) and the Total Cost of design, refinement and use of 2600 student-packages (box 19/17: $7151.04) is $4525.04. Thus, the cost of use of 2600 student-packages, exclusive of design and refinement is $4525 in Model One.

(5) To derive the cost of use of 1400 student-packages, take $\frac{1400}{2600}$ x $4525, yielding a total cost of $2436.56 for the use of 1400 student-packages. (This operation is allowed by assumptions (3) and (6)).

(6) The total cost of administering the output of Model Two for 100 students is therefore:

(a)	General consultation on requirements (Activity 1)	$1397.76
(b)	Package design and refinement	$2626.00
(c)	Use of 1400 student-packages	$2436.56
	TOTAL	$6460.32

Averaging this total cost over 100 students, yields an average cost per student of $64.60. Model Two thus becomes $11.35 per student cheaper than the lecture system (accounts, box 24/18), and $20.89 cheaper than Model One (accounts, box 18/18). On the assumptions we have made, the mathetical approach of tailoring instruction to individual needs is cheaper than uniform programs for everyone. This is an important result, and it will always be true as long as:

(1) Assumption (1) maintains,

(2) In the absence of assumption (6), diseconomies of smaller scale do not wipe out the reduction of average cost from reduced output as registered in Model Two,

(3) In the absence of assumptions (3), (4) and (5), the activities they concern do not incur high enough marginal costs to wipe out the reduction of average costs from reduced output as registered in Model Two.

Of course, Model Two is only one illustration of a departure from Model One. The accounts can accomodate more complicated situations and derive the relevant cost and outputs information by separate tabulations for each category of package user, by rate of use, consulting, re-testing, etc. We have spared ourselves this effort in the present presentation because it would add nothing fundamental to the discussion. We have sought to illustrate that the accounting framework we developed for cost-analysis can be used for program planning in both traditional and innovative learning systems. Innovative systems may require more redefinition of categories to fit the format; it is possible and hopefully, useful.

In the following section we illustrate an application of the accounting framework to an operative departure from the lecture system.

THE ECONOMICS OF CONTINGENCY MANAGEMENT IN AN INTRODUCTORY PSYCHOLOGY COURSE FOR ONE THOUSAND STUDENTS.

Psychology 150 at the University of Western Michigan represents a substantial departure from "traditional" course instruction. Unlike a traditional structure where the professor is often at the same time teacher, planner and evaluator (perhaps aided by paid assistants), Psychology 150 is a management system of education based on principles of behavioural psychology with respect to student instruction, course administration and course evaluation. The professor infuses the course with intellect, organization and control, but he personally conducts little teaching or ancillary duties. The course was designed to develop and demonstrate solutions to four major problems in higher education. These problems are, "(1) student underachievement, (2) large student/faculty ratios, (3) the high cost of education, and (4) the common complaint that a liberal education is difficult to achieve and irrelevant to the world of affairs." [31]

Our interest in this course is motivated by two connected concerns. Firstly, we wish to investigate whether substantial departures from "traditional structures" can make more efficient use of scarce resources and thereby cut costs, while they satisfy academic objectives of improved learning in a pleasant learning environment. Secondly, we wish to test the ability of our accounting framework to serve as an effective tool of cost analysis for this new structure. We are interested in determining whether the accounting framework is an effective aid to gain a detailed understanding of how Psychology 150 solves the third problem above: "the high cost of education".

---

[31] Mallot, Richard W. and Svinicki, John G., "Contingency Management in an Introductory Psychology Course for One Thousand Students", The Psychological Record, 1969. Vol. Pp. 545.

We divide our discussion into three main sections: (1) We sketch the academic aspects of the Psychology 150 system, (2) describe the structure of student and staff activities, and (3) analyze the operating costs of the system so described.

(1) The Academic Aspects of the Psychology 150 System:

Two main principles inspire the academic philosophy of Psychology 150: (1) The system should be able to encourage desired behaviour by an appropriate structure of punishment and reward. Behaviour is controlled by its consequences. (2) The system should undergo constant evaluation to measure the accomplishment of at least two important results:

(a) student and staff activities within the system are necessary and sufficient to accomplish the desired objectives, and

(b) the system keeps its participants' well motivated by insuring that course materials are not only academically sound, but also relevant to their interests, and that the incentive system is neither too lax nor too stern to maintain positive motivation.

With respect to the basic principles and philosophy of behavioural technology, Malott writes the following:

> "The most exciting development in contemporary psychology is the approach to behavior problems which has come to be called behavior modification. The first axiom of behavior modification is that psychological problems are essentially behavior problems.
>
> "The second axiom is that the principles of behavior established in the laboratory can be successfully used in solving these problems. The consistent success with which this approach has been met has provided more than ample support for these axioms. The first applications of the laws of behavior, established with laboratory

animals, to serious "mental disorders" in human patients required a bold imagination combined with a great faith in the generality of the principles of behavior.

"In theory, at least, the successful use of the behavior approach is quite simple:

"We specify the behavior that is to be modified.

"We observe whether or not the behavior occurs and,

"We consequate the behavior appropriately by rewarding, punishing, or ignoring it.

"In the abstract, these three steps all seem obvious; but when any specific, non-trivial case is suggested, we are overwhelmed with reasons why none of the three above steps can be carried out. At that point we need imagination and faith.

"During the last ten years, there has been widespread application of the behavioral approach to the modification of behavior abnormalities in hospitals, clinics, and schools. Within the last four years, these techniques have been applied in educational settings from nursery school through college. It may be that the next significant breakthrough will be in the area of personal control; i.e. individuals will learn how to modify their own behavior in any direction they wish.

"This raises the apparent paradox that a deterministic science will provide man with the techniques for obtaining his own personal freedom."[32]

We produce extracts from Malott and Svinicki

to illustrate how the principles of behavioural technology aid student achievement in Psychology 150. The authors write as follows:

---

[32] Malott, Richard W., "Its Great to be Alive in the 20th Century", folder, 1969.

> "In a representative institution of higher education, 10% of the students are customarily on academic probation; many are eventually dismissed from school. This highlights the problem of student underachievement plaguing higher education. The customary failure of students to achieve their potential is widespread.
>
> "In spite of this state of affairs, it may be that all students meeting the normal entrance requirements of a college are capable of doing "A" level work at that college. Furthermore, it may be possible to design an educational system in which most students will attain this level of accomplishment (cf. Ferster, 1968; McMichael & Corey, 1969).

"Daily Reading Assignments and Quizzes."

> "While some students work hard and earn the grade of "A" in their courses, others work very little and earn much poorer grades. None-the-less, grades may be effective reinforcers for nearly all college students. The problem is that the schedule of reinforcement is too intermittent to maintain the behavior of many students with deficient histories. Students who appear unmotivated may work industriously if the proper schedule of reinforcement were used. Without the proper training history, laboratory animals, required to make a large number of responses for each reinforcement, may respond very poorly. However, if the reinforcements are programmed more frequently, they may respond well.
>
> "In the introductory psychology course at Western Michigan University, the usual infrequent hour exams over large reading assignments were eliminated. In their place there are brief daily quizzes over 1 hour daily reading assignments. This schedule seems to maintain more reading behavior than the usual hour exams. In

addition, the students avoid the tendency to wait until the day before the hour exam to try to cram a large amount of material. Cramming on only an hour's reading assignment is essentially not cramming. When first exposed to daily quizzes, students may object; however they soon come to prefer daily quizzes to hour exams.

"Clear Specification of the Responses to be Learned".

"In order to facilitate high student achievement, an attempt is made to specify as clearly as possible what will constitute mastery of the reading assignments. In the case of the programmed text material there is little ambiguity; however with the non-programmed material, there is considerable room for judgement. For these latter materials we provide a set of reading objectives with each assignment. They indicate what the student should master. ...

"Opportunities for Make-Up Work".

"The regular daily quiz consists of two brief construction-type questions. If the student misses one or more of these questions, he has the opportunity to attend one of several make-up quizzes over that reading assignment. The first make-up quiz is given the evening of the regular quiz and follows a 40 minute remedial lecture over the day's reading assignment. If the student does not answer all six questions correctly or does not attend the make-up quiz that evening, several other opportunities for make-up quizzes are given during the remainder of the week and weekend."[33]

100% Mastery Required.

The authors explain that 100% mastery is required in quiz performance. Students are graded on the basis of four activities: labs, seminars, quizzes, mid and final term exams. In order to maintain behaviour in all activities, the final overall grade for the course can be no higher than the lowest final grade achieved in any one of the four activities. The exception to this is the exams, where relatively poor performance cannot penalize the student more than one letter grade below that which he would have earned in the absence of the exam. Letter grades range from A to E, E being a failure. With respect to quizzes, missing a quiz means that a student either failed to take it, or failed to gain 100% even after all the make-ups. The contingencies for quiz behaviour are as follows:

---

[33] Malott and Svinicki, op. cit., pages 545-550.

Students who miss:

1-2 quizzes may receive a final quiz grade of	A
3-4:	B
5-8:	C
9-12:	D
13 or more:	E

Similarly with labs:

"In order for the student to receive any credit for a laboratory experiment, he must complete the experiment and turn in an "A" level write-up of that experiment. Before the experiment can be considered complete, the animal's behavior has to be demonstrated to the teaching apprentice."[34]

Students conduct four experiments per semester, attending labs one hour per day, four days a week over seven weeks. The behaviour these requirements elicit is impressive:

> "The result of all this has been that, out of more than 1,000 students, fewer than 12 failed to complete all four experiments and none failed to complete at least three experiments. Of those that failed to complete all four experiments, several were students for whom one or more rats died during the term."[35]

Other factors also improve achievement:

"Error Analysis"

> "As anyone who has used test questions knows, an alarmingly high percentage of the questions are poor. An error analysis is made of the quiz questions and on the basis of the error analyses, all of the questions are corrected and improved. Where there is a high level of error, yet the question appears satisfactory, the reading material may be inadequate. An attempt is made to compensate for this in the make-up lectures and the reading objectives by emphasizing the especially difficult parts.

"Immediate Feedback"

> "Students are given immediate feedback on performance on the quizzes; as soon as the quiz papers are collected, the correct answers are read. If the students have any questions, they may ask the individual giving

---

[34] Ibid.

[35] Ibid.

the quiz. In addition, all of the students' scores are posted daily and cumulated weekly along with a grade distribution; so that, each week, the student knows exactly where he stands in terms of a letter grade for the course.

"Procedure Quiz"

"No matter how clear the objectives and instructions are, the student must read them before they can be effective. We have observed that students tend to come to the laboratory unprepared. In order to reduce this, the students are given quizzes over the laboratory procedure sheets prior to each experiment. In addition, a video tape is shown demonstrating proper techniques for each experiment.

"Students are also given quizzes over the laboratory style manual and the general course procedures. In addition they are quizzed over the special material they are to analyze in the discussion sections; this reduces the likelihood that a student's discussion will be hampered by his not having recalled the material.

"Absence Policy"

"During the first year that we taught this course, the correlation between unexcused absences and grades in the course showed a tendency for students who had less than four unexcused absences to have final grades of A or B and for students who had more than four unexcused absences to have C's or lower. Though there are many possible interpretations of this correlation, the more absences the student has, the fewer the number of points he can earn, and therefore the lower the grade he is likely to earn. A student might gradually slip from one grade to the next through repeated absences. No single absence is very important, but the cumulative deficit can be considerable. In order to prevent this we allow a maximum of four unexcused absences. The student receives no credit for the day if an unexcused absence occurs; and if he has more than four unexcused absences, he receives an "F" for the entire course. This has virtually eliminated excessive unexcused absences. Only absences which can be documented as legitimate are actually excused.

"Results"

> "What has been the level of achievement attained as a result of these various procedures? The students work about 12 hours per week for 3 hours of credit; 80% to 90% earn a final grade of "A" and less than 2% receive an "F". This is the case even though high academic requirements are imposed." 36

Another index of student achievement is the practical use value of the material they learn in class:

> "The educational experience which seems to be most universally motivational and inspirational involves working directly with people who have behavior problems in an effort to help them. Our students are able, after only one course in psychology, to work in supervised behavior modification projects with individuals who are seriously in need of help. Such experiences quickly point up the importance of the concepts the apprentices have learned in the classroom. That the apprentice is not involved in a mere academic exercise is readily apparent, for in many cases the students are working with human beings who have needed help for a long time and who would receive no help if it were not for them. At present, our students are working in the Kalamazoo Valley Intermediate School District, the Fort Custer State Home, and the Kalamazoo State Hospital." 37

Perhaps another reason for this result is that the learning materials of the course are structured to achieve an integration of scientific method and applied behavioural science right from the beginning. In this

---

36. *Ibid*.

37. Malott, Richard W., "Its Great to be Alive in the 20th Century", folder, 1969.

respect the authors comment on the relevance of liberal education:

> "Students often complain that the relevance of a liberal or general education to the affairs of the world is not sufficient to maintain their interest. Faculty members frequently confess that the goals of a liberal education are rarely achieved by education programs actually in existence. Furthermore, it is commonly stated that the attainment of a liberal education is incompatible with the attainment of a relevant or practical education. We believe that these two types of education may be achieved simultaneously and may in fact reinforce one another.
>
> "One of the problems of a curriculum aiming toward a liberal education is that no adequate framework has been developed to integrate the various traditional academic divisions and at the same time provide a framework for bringing them together.
>
> "By being sensitive to the interests of the students, an introductory course was developed whose relevance and importance is generally obvious. Programmed texts are our primary means of teaching the principles of behavior; however nearly half of the reading assignments and nearly all of the lectures are devoted to emphasizing the relevance, utility, and importance of the principles of behavior. Little effort is made in this introductory course to teach the value of an abstract science; instead the role of the principles of behavior in the analysis and control of significant human behavior is emphasized. This has been greatly facilitated by the experimental material now available in behavior modification. No attempt is made in this first course to give an overview of all the various fields of psychology or the various approaches to be found in psychology. Nonetheless the general approaches and problems to be found in the natural sciences, social sciences, and humanities are illustrated in this course."[38]

---

[38] Malott and Svinicki, *op. cit*. , page 554.

Despite the large numbers of students enrolled in the course, the system was developed to facilitate the kind of learning experiences that only come in small group situations.

In their discussion of the student/staff ratio problem, the authors explain how they improve learning effectiveness by the use of an inexpensive and controlled system of small group instruction:

> "A widely recognized problem in higher education is the rapidly increasing number of students for each faculty member (student/faculty ratio). A common method for dealing with this is the use of large lecture sections as the primary in-class teaching technique, combined with the redefinition of educational goals in terms amenable to multiple-choice, machine-scored, objective examinations. An alternative solution is needed. Laboratory experiences and small group discussion are valuable teaching techniques; oral and written verbal expression, creative behavior, and content mastery assessable only by essay examinations ought not be neglected.
>
> "One alternative solution is based on the evaluation of student performance by the students themselves. The work of students in small discussion groups and laboratories, laboratory report writing, and essay examination performance is graded by fellow students. In some instances, the grading is done by peers; in other instances, th grading is done by more advanced students. Quality control is maintained by a sampling system involving other advanced students, teaching assistants, and faculty.

"Peer Grading"

"One of the purposes of a course such as this is to develop verbal and oral fluency concerning the course subject matter. It is important that the students have an opportunity to emit verbal responses and for those responses to be reinforced. However, even in relatively small classes, there is little opportunity for all but the most locquacious of students to do this. In a 50 minute discussion class of 25 students, each student has an average of 2 minutes recitation time. Of course, even the most non-directive instructors utilize a large amount of this time and the rest is taken up by a small number of highly verbal students. Most students hardly recite at all.

"Four-man student-led discussion groups were developed to deal with this problem. Students fill in detailed grading sheets each day evaluating the other three students in their discussion groups. There are obviously many difficulties with this. One problem is that of collusion; all of the students may agree to give each other good grades. We have attempted to reduce this by rotating the students through the various discussion groups each day. Each discussion group sits at a separate table which contains a microphone. A student teaching apprentice listens to the various tables during the discussion. Although he only listens to one table at a time, the students never know which table it is. If the students' evaluation of the speakers varies considerably from that of the apprentice, they receive a zero for the day's seminar.

"Another major problem with peer grading is that of whether or not the students are able to accurately grade each other even if they are being conscientious. It is hoped that the discussion text is programmed adequately enough that the four students can come to a consensus during the discussion about the correctness of the talks which will be reasonably close to a correct response as defined by the instructor."[39]

---

[39] *Ibid.*

The delegation of instructional duties to students involves an elaborate network of task distribution and performance verification. By applying behavioural principles to the accomplishment of the student instructors, the system maintains good performance and provides useful pedagogic experience for the participants. It is on these grounds that their efforts are largely remunerated by academic credit rather than cash.

The system incorporates the extensive use of evaluation techniques not only to monitor student performance, instructor performance, and the adequacy of quiz questions, but also to deal with the larger issues of (a) the needs, interests and problems of the individual student, and (b) the necessity and sufficiency of activities in the system.

With respect to the needs, interests and problems of the individual students, the authors explain as follows:

> "It is usually felt that as the student/faculty ratio increases, the faculty are less aware of the needs, interests, and problems of the individual student. We

have made systematic attempts to deal with this problem by obtaining elaborate student evaluations of each reading assignment, each laboratory experiment, each discussion meeting, and each lecture, as well as the overall course. On the basis of the student's opinions of the interest, value, clarity, etc. of the many units of the course, these units have been drastically modified and in many instances eliminated. Face-to-face interviews with a small sample of individual students are also conducted by the faculty and assistants. These techniques combined with the results of error analyses of the individual quiz questions give the students a degree of control over the course which is much greater than is customary. We are able to be much more responsive to the wants and needs of the students in this large course than is usually the case with smaller courses using more traditional techniques."[40]

In their unpublished article, "Contingency Management Revisited", James M. Palm and Dr. Richard W. Malott give specific examples of substantial changes that have been introduced to cope with specific problems, and with areas of student dissatisfaction.

We briefly review the essence of several:

(a) *Doomsday Contingency*: In the initial development of the course, if students did not perform with "A" in *all* the quizzes after all chances for remediation, they were required to drop the course or get an "E" after the first failure. This created student unrest, and put undue pressure on the teaching apprentices to become lenient. The planners subsequently eliminated Doomsday Contingency.

(b) *Exams*: In 1968, there were no mid-term or final exams. Students acquired much short term mastery, but long run retention was poor. The planners introduced exams to overcome this problem. No student who performed poorly on the exam could be lowered by more than one letter grade below that which he would have earned in the absence of the exam, and those students who failed two quizzes or less during the term could still earn "A" for the course with a minimum of 70% on the final exam.

---

[40] *Ibid*, page 551.

To assess the necessity and sufficiency of activities in the system, Dr. Malott encourages his graduate assistants to write their Master's dissertations on evaluations of specific activities. A recent result of one such dissertation may lead to the substitution of seminar activity for something else, because the author discovered that the marginal product of seminar activity is not worth the amount of time and effort it involves. Another dissertation on the longer run effectiveness of the daily quiz has incited the staff to conduct further enquiries into this activity.[41]

---

40. (c) Remedial Quizzes: In 1968 they were held on Friday and Saturday. In only one of the five requiz sessions did the planners provide a forty minute remediation period before the ten minute quiz. The planners learned that week-end requizzing was particularly inconvenient for students who missed more than one quiz during the week, and the students needed more remediation. They rescheduled remedial quizzes to occur during the week and generalized remedial instruction of 40 minutes to all requiz sessions.

41. We discovered that evaluation can easily be a way of life. After two six hour sessions of concentrated effort to analyze the theory and mechanics of Psychology 150, Dr. Malott wondered what we accomplished in that period, and of what use it will be. We invite the reader to ask and answer the same questions for himself.

Our interest in these experiments is inspired by the consideration that they are precisely the kind of controlled learning situations that should inform on the nature of efficient instructional production functions.

In this section we attempted to summarize the essence of the academic aspects of Psychology 150. We now turn to a more detailed examination of the structural and financial features of the system.

(2) The Structure of Student and Staff Activity in Psychology 150:

The course spans a semester of fourteen to fifteen weeks. The student is responsible for the following reading materials:

(i) "Elementary Principles of Behavior" by Whaley and Malott,

(ii) "Two other psychology textbooks,

(iii) "Attitudes of Science—A Program for a Student Centered Seminar" by Whaley and Surratt,

(iv) "The Big New Mother Mind Boggling Behavior Expander", By Malott—a lab manual.

The student attends one lecture per week, every

Friday, one or two of which are given by Dr. Malott, the remainder consisting of films on scientific method and related subjects[42], as well as several guest lecturers.

For seven weeks of the semester the student attends seminars one hour per day, four days per week, (Monday to Thursday inclusive). In the seminar, he is a member of one group of four students, there being six such groups of four in any one hour session.

For the first ten minutes the students write a quiz, two questions of which are usually based on the Whaley-Malott text, the other on the "Attitudes to Science". The student spends the remaining forty minutes discussing subjects in "Attitudes to Science". He peer-rates his fellow discussants, and he loses points for not rating in a manner consistent with that of the teaching apprentice who may be listening to the discussion.

For another seven weeks the student attends labs, one hour per day, four days a week (Monday to Thursday inclusive). For the first ten minutes he writes a quiz, two questions of which are usually based on the Whaley-Malott text, the other on the lab manual. He spends the remaining forty minutes conducting his experiment. Every week he submits a lab report summarizing the state of his experiment. The lab reports take little time to write or correct because they are of the "fill-in-the-blank" variety.

---

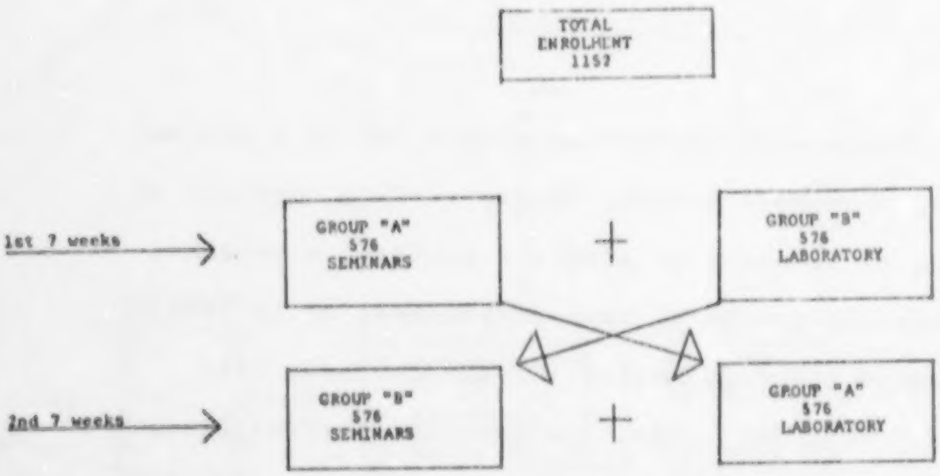
[42] The university purchases the films for approximately three hundred dollars each, and uses them frequently in a great many courses.

The student writes two exams during the semester, and has other duties such as filling in evaluation sheets, and looking after rats.

To give the reader an overview of the global structure that student activity in labs, seminars and quizzes constitutes over the period of the semester, we refer to Figure IV: "Replication Structure—Student Activity". It begins with an optimal enrolment of 1152 students. This enrolment is then distributed between two sections (which we label "A" and "B") of 576 students each. As labs and seminars are not sequential activities, in the first seven weeks section B attends labs while section A attends seminars. In the second seven weeks they switch; the former lab section becomes the seminar section and vice-versa.

FIGURE IV.

REPLICATION STRUCTURE - STUDENT ACTIVITY


TOTAL
ENROLMENT
1152
1st 7 weeks
GROUP "A"
576
SEMINARS
+
GROUP "B"
576
LABORATORY
2nd 7 weeks
GROUP "B"
576
SEMINARS
+
GROUP "A"
576
LABORATORY

TIME				
8	24 in 4's	24 in 4's	24	24
9	24 in 4's	24 in 4's	24	24
10	24 in 4's	24 in 4's	24	24
11	24 in 4's	24 in 4's	24	24
12	24 in 4's	24 in 4's	24	24
13	24 in 4's	24 in 4's	24	24
14	24 in 4's	24 in 4's	24	24
15	24 in 4's	24 in 4's	24	24
16	24 in 4's	24 in 4's	24	24
17	24 in 4's	24 in 4's	24	24
18	24 in 4's	24 in 4's	24	24
19	24 in 4's	24 in 4's	24	24

DAILY MONDAY THROUGH THURSDAY
INCLUSIVE

M 17646

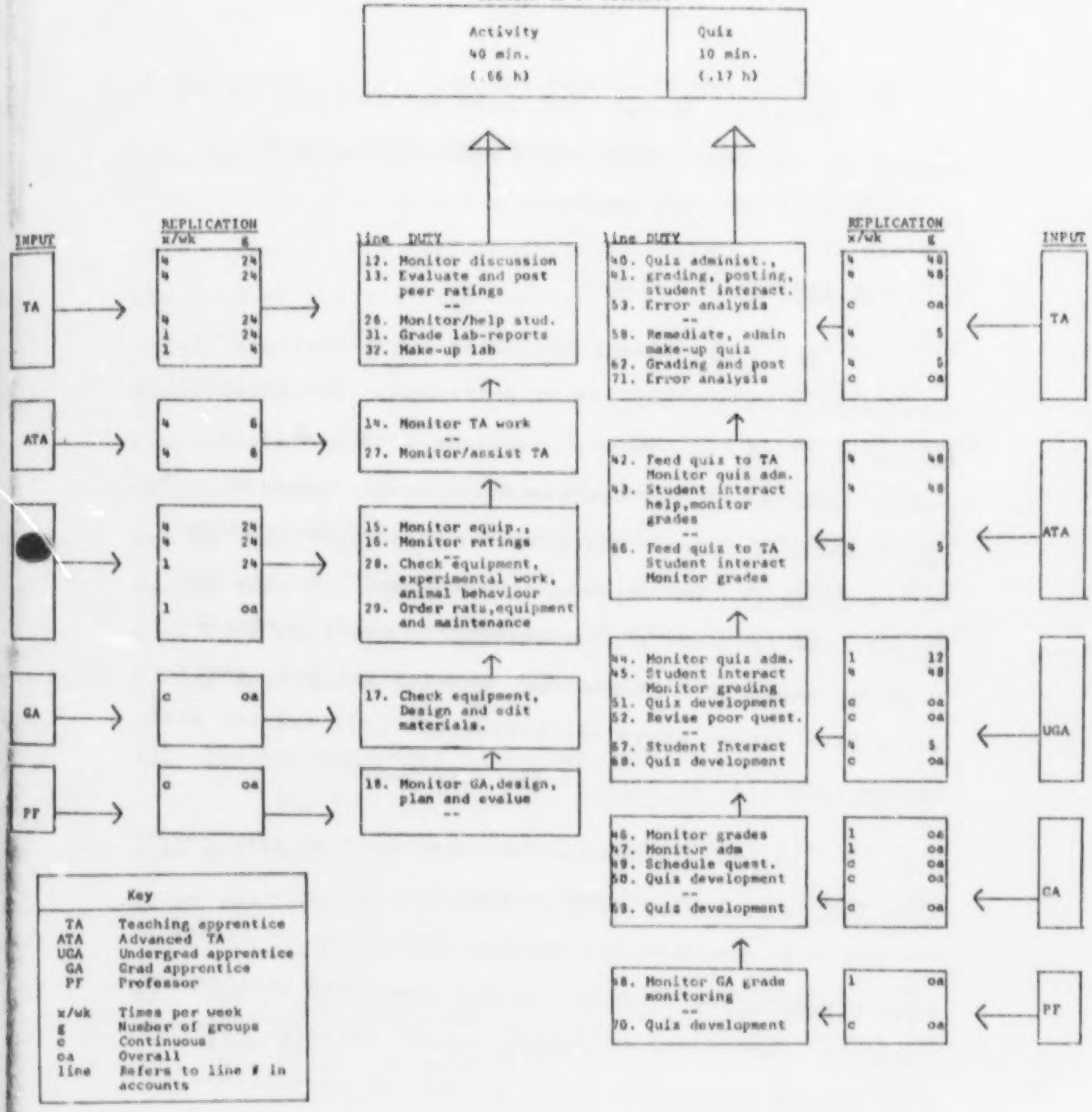
Since each student attends a lab or a seminar every day, four days a week, the scheduling consists of two groups of twenty-four students meeting in seminars and another two groups of twenty-four meeting in labs every hour of the day, Monday through Thursday from 8 A.M. to 7 P.M. inclusive. In sum, forty-eight groups of 24 meet per day, yielding the total amount of activity for 1152 students.

(b) Staff Activity:

The groups of 24 students have an extensive association of staff activities. To give the reader an overview of the system, we refer to Figure V: "Replication Structure—Staff Input". It begins with a representative group of 24 students, divided into two student activities—the forty minutes of discussion or experiment, and the ten minutes of quiz. It then illustrates the structure of staff activity that supports each of the two student activities in the group, beginning with the teaching apprentices (the "front line troops") and working its way back to the professor in charge.

FIGURE V.

REPLICATION STRUCTURE - STAFF INPUT


SESSION OF 24 STUDENTS
Activity
40 min.
(.66 h)
Quiz
10 min.
(.17 h)
INPUT
REPLICATION
x/wk
g
line DUTY
TA
4 24
4 24
4 24
1 24
1 4
12. Monitor discussion
13. Evaluate and post peer ratings
--
26. Monitor/help stud.
31. Grade lab-reports
32. Make-up lab
ATA
4 6
4 6
14. Monitor TA work
--
27. Monitor/assist TA
4 24
4 24
1 24
1 oa
15. Monitor equip.,
16. Monitor ratings
28. Check equipment, experimental work, animal behaviour
29. Order rats,equipment and maintenance
GA
c oa
17. Check equipment, Design and edit materials.
PF
c oa
18. Monitor GA,design, plan and evalue
--
line DUTY
40. Quiz administ.,
41. grading, posting, student interact.
53. Error analysis
--
58. Remediate, admin make-up quiz
62. Grading and post
71. Error analysis
REPLICATION
x/wk
g
4 48
4 48
c oa
4 5
4 5
c oa
INPUT
TA
42. Feed quiz to TA Monitor quiz adm.
43. Student interact help,monitor grades
--
66. Feed quiz to TA Student interact Monitor grades
4 48
4 48
4 5
ATA
44. Monitor quiz adm.
45. Student interact Monitor grading
51. Quiz development
52. Revise poor quest.
--
67. Student Interact
68. Quiz development
1 12
4 48
c oa
c oa
4 5
c oa
UGA
46. Monitor grades
47. Monitor adm
49. Schedule quest.
50. Quiz development
--
69. Quiz development
1 oa
1 oa
c oa
c oa
c oa
GA
48. Monitor GA grade monitoring
--
70. Quiz development
1 oa
c oa
PF
Key
TA Teaching apprentice
ATA Advanced TA
UGA Undergrad apprentice
GA Grad apprentice
PF Professor
x/wk Times per week
g Number of groups
c Continuous
oa Overall
line Refers to line # in accounts

M. SEGAL

First we discuss the important features of the seminar or lab inputs (left hand side of Figure V). then those of the quiz inputs.

(i) Lab and Seminar Inputs:

The input column indicates the kind of staff associated with the duty to be performed. The replication column indicates the rate per week and the number of groups affected by the corresponding staff activity. The line reference relates the activity to its description in the Accounts (See section 3 below) and finally, the duty is the job that the corresponding staff performs. Wherever there is a distinction between the two, seminar activities appear above the broken line(--) and lab activities below it, in each of the duty boxes.

We briefly examine the character of some duties:

(1) The Teaching Apprentice (TA):

He monitors the seminar discussion by listening into groups of four according to a specified replication schedule. He evaluates and posts peer ratings, monitors and assists students in labs, grades lab reports and attends the make-up labs which are provided for students who do not successfully complete their lab the first time.

(2) The Advanced Teaching Apprentice (ATA).

In each of the seminar and lab sessions, four days a week in six different groups a day, the ATA monitors the work of the TAs with respect to both performance of duties and rating of student discussions. The TA is fully aware of the basis on which he is rated, because at the beginning of term he receives a manual and other duplicated material which indicates what his responsibilities are, how he should go about executing them, and how many points he may lose for not performing any particular duty.[43] Very much like that of the students, his behaviour is consequated by the next higher rank in the hierarchy.

(3) The Undergraduate Assistant (UGA):

The UGA monitors the performance of the ATA on a sample basis. He pulls one or two ratings from each group everyday to monitor the monitoring of the ATA. He

---

43. See "T.A. Manual and Grade Book for Psychology 150", Western Michigan University, Kalamazoo, 1970. See also annexed sheet: "Teaching Apprentice Duties or 'How Will I be Graded?'".

checks equipment and the experimental work of the students. He also handles ordering and maintenance of lab supplies and equipment.

(4) The Graduate Assistant (GA):

The GA monitors the equipment maintenance of the UGA, and helps the professor to design and edit material for the seminars.

(5) The Professor (PF):

He monitors the performance of the GA, designs, plans and evaluates the seminar discussions.

(ii) Quiz Inputs:

Since quiz administration is a homogeneous activity for seminars and labs, we make no distinction between them; the group numbers in the replication column (right hand side of Figure V) cover the whole system—labs and seminars together. The distinction which applies to quiz activity is that between regular quizzes given in class, and remedial quizzes scheduled at other times. Regular quiz activity appears above the broken line (--) in the duty boxes, and remedial quiz activity below it.

The structure of duties and control is similar to that we related with respect to the left hand side of the figure. The reader may examine the content of the duty and replication boxes to gain an understanding of how the quiz administration functions. An interesting feature of the system is the amount of scope it incorporates for staff to interact with students about the quizzes and related matters.

The figure "Replication Structure—Staff Input" does not exhaust the activities that staff execute in connection with Psychology 150. A complete account of the remaining activities appear in the Accounts, an explanation of which we develop in Section 3 below.

(3) The Operating Costs of the Psychology 150 System:

We discuss the economics of the system under the following headings:

(A) The Adaptation of the Standard Accounting Framework to Psychology 150,

(B) The Determination of Values,

(C) Data Analysis.

(A) The Adaptation of the Standard Accounting Framework to Psychology 150:

The accounting framework requires very little adaptation to handle the structural and financial information we require to analyze the costs of this complex operation.

In the traditional structure, the valuation basis of staff input in terms of contact hours, (with the exception of some administrative and evaluative duties) meant that for the most part we could account for student participation and staff input on the same line of the accounts for any one activity. Where departures from this practice were required, we listed the activity, noted the total time commitment required in the "Ta" column, the pay rate in the "SA" and "x" columns, and then proceeded to calculate the total cost and unit cost per student.

The main difference between Psychology 150 and traditional structures, as far as systems are concerned, is that the former system involves a complex and structured organization of staff inputs where it is more relevant to think of teaching duties in terms of the management and hierarchical distribution of varied workloads, rather than contact hours alone. Furthermore, the sequencing and volume of these activities differ from one level of the hierarchy to another and they do not maintain an identical sequence or volume to student activities. For these reasons, we have modified slightly the presentation of the accounting data (see page 360) such that the sequence and volume of student effort in any one activity is presented distinctly from its associated structure of staff inputs. The costing is calculated in terms of the staff inputs, meaning that the "student effort" accounting stops at column 12 ("Ta").

The distinction between student and staff activity is clearly indicated just before column (1) by the symbols "SP" for student participation, and "RC" for resource commitment. For example, lines 9 and 10 describe student participation in seminars as follows:

"For each of two sections (GR. A and GR. B) 576 students broken into 24 groups of 24 each, attend 40 minutes of seminar discussion four times a week over a seven week period, yielding a requirement of 444 hours of seminar activity per seven weeks to provide each student with 18.5 hours of seminar per seven weeks." Line 11 sums the requirements for both groups.

On the other hand, line 15 describes one of the staff inputs for seminars as follows:

"The UGA monitors equipment over 14 weeks, every week 4 times a week for five minutes each time for 24 groups. This requires 20 minutes (.33 hrs.) per week for one group (h), 7.92 hours per week for all 24 groups (Tb) and 111 hours per semester (Ta). He is paid $1.50 per hour, yielding a total cost for the activity of $166.50."

For all "RC" lines, the columns describing time sequences refer to staff rather than to students, and the "g" column (col. 10) refers to the number of groups affected by one round of activity as described in the time sequence columns. Thus, in line 1[illegible], 6 groups are affected four times a week, every week over 14 weeks for 40 minutes (.66 h) a session in the activity of monitoring TA performance.

There are staff inputs for which it is not relevant to specify a time sequence of activity. Either it happens erratically, continuously, or all at once.

In these cases, "s" (col. 1) assumes the value of 1, "d" (col. 3) assumes the value of the total time commitment per semester, and the same value is repeated in "Ta" (col. 12).

The departure from contact hour accounting where it is not relevant, means that we require accurate estimates of the amount of time needed to accomplish any task using staff resources. It is inherent in the behaviourist approach of the Psychology 150 organization that job specifications, performance criteria and consequation be clearly specified. This in turn means that the builders of the system know how much time and effort is required to perform the jobs. Under these conditions, we have reasons to believe that the time estimates are as reliable as we are likely to find in any university setting.

With respect to time measurement, for column (3), "d" the following values apply:

When the time is:	"d" is:
1 hour	1
40 minutes	.66
30 minutes	.5
20 minutes	.33
15 minutes	.25
10 minutes	.17
5 minutes	.083
2.5 minutes	.042

We make one final comment on the method of accounting C, CU, CH and A with the slightly revised format.

C assumes two values, because the numeraire in Psychology 150 is not only dollars but also credit. Column 18 indicates the cost of each task in an activity; the distinction between dollar pay and credit pay is indicated by the symbols "$" and "CT" respectively. The total value of CT for the activity appears underlined in column 17 with the notation CT immediately to the left of the value.

CU is calculated for dollar costs only in the standard way. CH is calculated for dollar costs only in the standard way. The value of "Ta" used in the calculation is the number of dollar paid staff hours committed to the activity. While "Ta" total in column 12 indicates the combined quantity of dollar and credit paid hours of staff activity, this quantity is disaggregated into credit hours and dollar hours in column 11, just beside the combined total. For example, in line 7 while column 12 indicates a total of 148 staff hours, column 11 indicates that 56 are paid in credit, 92 in dollars.

The value of "A" is derived by applying the formula $A = \frac{CU}{Pe}$ at the level of each activity total. The average value of "A" over all activities in the course is derived by applying the same formula, using the values of CU and Pe of line 126, representing the sum of CU over all activities, and the sum of Pe over all activities in which students participate.

(B) The Determination of Values:

There are a number of derived values in the accounts which require explanation. They are:

(1) The credit value of one hour of Ta or ATA time,

(2) The dollar value of one hour of GA time,

(3) The dollar value of one hour of professorial time,

(4) The current value of investment in materials development,

(5) The simulated values of a "comparable" traditional structure.

We discuss these items *seriatem*.

(1) The credit value of one TA or ATA hour:

In Western Michigan University, students normally receive one credit for one lecture plus a theoretical two hours of outside study per week. Therefore, one credit is the equivalent of 42 hours of work over a 14 week semester, and one hour of work is worth 1/42 credits, or .024 credits.

(2) The dollar value of one hour of GA time:

A GA is paid $1300.00 over a 15 week period and is expected to work 20 hours per week, yielding an hourly rate of $4.33.

(3) The dollar value of one hour of professorial time:

The professor earns $12,000 for two semesters, teaches three courses, and estimates that 50% of his time is devoted to Psychology 150 because it is a larger and more complex operation than the other two courses. The cost of the professor for the one semester course is therefore $3000.00. The sum of his time commitments to all activities in which he participates is 217.7 hours, yielding an hourly rate of $13.78.[44]

(4) The Current Value of Investment in Materials Development:

With respect to the development of quiz questions (Accounts, lines 50 and 51), Dr. Malott estimates that the useful life of one set of questions should be approximately three years, or six semesters. We depreciate the investment of 200 hours of GA time and 100 hours of UGA time devoted to quiz development evenly over the six semesters, yielding 33.3 and 16.7 hours of time respectively per semester.

Revision of questions (Accounts, line 52) consumes 25 hours per two semesters, or 12.5 hours per semester.

---

[44] It may be of some interest to note that anyone working for eight months (22.5 weeks), forty hours per week at a rate of $13.78 per hour would have a gross pay of $12,402.00 for the period--fairly close to the $12,000 of the professor for the same time period.

The error analysis (Accounts, line 52), requires 300 hours TA time, which depreciated over six semesters yields 50 hours per semester.

The same rates of depreciation apply to investment in the development of remedial questions and error analysis (Accounts, line 68-71), the values to be depreciated being: 150 UGA hours, 150 GA hours, 10 professorial hours and 50 TA hours, yielding depreciated values per semester of 25, 25, 1.7, and 8.3 hours, respectively.

(5) The Simulated Values of a "Comparable" Traditional Structure (Accounts line 131-135):

We sought to compare Psychology 150 with a traditional structure, using Western Michigan pay rates and making reasonable hypotheses about workloads, in order to situate the costs of Psychology 150 relative to what they may have been were more traditional practices followed.

In doing so, we made the following assumptions. They compare with usual practices in other universities:

(a) The professor's instructional workload consists of Western Michigan University's standard 12 contact hours per week yielding 336 contact hours per academic year.

(b) The teaching assistants are graduate students paid $4.33 per contact hour plus another $4.33 to cover background work of preparation, seeing students, helping to set the exams, marking papers, etc. This yields a rate of pay of $8.66 per contact hour.

(c) Demonstrators are graduate students paid at a rate of $4.33 per contact hour, plus 50% of this rate for ancillary duties such as marking lab reports, seeing students and a very modest amount of clerical work.

(d) We sought to standardize the student input (measured in contact hours), for purposes of maintaining comparability. The total student input ("Pe" col. 6) of 63 hours per student per semester in the traditional structure is 2.5 hours greater than that of the Psychology 150 system, the difference being that we accounted with 50 minute hours in labs and seminars of the Psychology 150 system and with 60 minute hours in the traditional structure. It matters little to cost differences because much of the contact time with students in labs and seminars of the Psychology 150 system is performed by TAs and ATAs who are paid in credit, not cash. Most cash-paid hours in the Psychology 150 system are 60 minute hours. In both systems, the students attend 1 lecture per week for 14 weeks, 4 hours of seminar per week for seven weeks and four hours of lab per week for seven weeks. We also maintained comparable staff-student ratios, with 288 per class in lectures and 24 per group in labs and seminars. The cost comparison is thereby structured to indicate the effects of using student inputs paid in credit and a different distribution of workloads between various categories of staff.

(C) Data Analysis:

From line 126 of the Accounts, we estimate the total cost of the course to be $7,666.66; cost per student:

$6.64; average cost per hour: $2.96; and average cost per student per hour: $0.11. This makes Psychology 150 by far the most inexpensive course of any we have had the occasion to examine. The low cost per student is all the more remarkable given the amount of activity the system supports.

We believe that two factors are mainly responsible for this result:

(1) the large scale of the operation, and
(2) the economic management of human resources.

We believe that both factors are necessary to minimize costs. Other courses we have seen which operate with as many or more enrollees do not cost so little. The traditional structure we simulated in line 135 of the Accounts costs $13.58 per student, while a course of 1246 students we analyzed in Part III costs $89.62 per student over two semesters. Their utilization of human resources is costlier than that of Psychology 150. Yet the resource utilization pattern of Psychology 150 may well be relatively uneconomic at much lower scales of operation. This is the case because not all factors vary proportionately to enrolment. There are fixed factors over large ranges of enrolment.

In Table VI below, we summarize the workloads and costs of each activity from the activity totals in the Accounts.

TABLE VI SUMMARY OF ACTIVITIES

Accounts Line	Activity	CT hrs	$ hrs	CT C	$ C	CU
7	Lectures	56	92	1.3	394.72	.34
20	Seminars	1446	291	34.7	1229.40	1.07
34	Labs	1404	87	33.6	222.60	.19
55	Quizzes	1617	227	38.8	535.72	.47
73	Remediation-Requiz	1566	100	37.5	241.18	.80
82	Exams	124	62	2.9	211.86	.18
89	TA Meetings	868	105	20.8	296.17	.26
93	Central Excuse System	21	28	.5	42.00	.04
94	Clerical Work	-	560	-	1260.00	1.09
1[illegible]	Staff Recruitment	25	45	.6	81.65	.07
11[illegible]	Evaluations	100	343	2.4	2375.76	2.06
120	Materials Development	125	-	3.0	-	-
124	Public Relations	-	70	-	775.60	.07
	TOTALS	7352	2010	176.0	7666.66	6.64

In general, the workloads paid in credits may vary with enrolment, however much of the work paid in cash would remain constant whatever the enrolment. We examine the enrolment sensitivity of cash-paid workloads seriatem, where $\underline{C} > \$100.00$.

(a) Lectures: Given the same kind of lecturing, the GA and the UGA would still have to perform the same organizational functions for large or small enrolments (Accounts, lines 3 and 4). Were the enrolment sufficiently small to eliminate several groups, several contact hours of professorial time may be eliminated. The minimum number of lectures the professor would give is two, (were enrolment quartered *cet. par.*) the other six being repetition. Thus, he prepares the same material whether he lectures twice or eight times a week. His annual salary is constant in either case.

Were enrolments quartered, he may use the six hours in some other activity connected with the course, or he may leave them idle. In the former case his hourly rate remains constant, while in the latter case it goes up proportionately to the workload reduction. The saving over all of the course is therefore nothing.

(b) Seminars: The cash-paid workloads consist of monitoring equipment, designing and editing materials, planning and evaluating the sessions. Some sample monitoring is also involved. (Accounts, lines 15, 16, 17 and 18). The total dollar cost of the activity is $1229.40. According to the Accounts, the only paid workload which varies according to

the number of groups is monitoring of equipment (line 15). The total value of this activity is $166.50. The remainder is "intellectual overhead" and this probably does not vary with enrolment.

(c) Labs: The total dollar cost of the activity is relatively low, and only $85.50 of it (Accounts, line 28, checking experiments and animal behaviour) is likely to vary with enrolment.

(d) Quizzes: Of $535.72, $210.75 may vary with enrolment (Accounts, lines 44 and 45, monitoring quiz administration and grading; interacting with students). The remainder is either intellectual overhead, or monitoring that involves a sampling procedure the volume of which probably varies little in relation to changes in enrolment.

(e) Remediation-Requiz: The activity is relatively inexpensive, and only $72.00 of it (Accounts, line 67, interacting with students) is likely to vary with enrolment. The remainder is intellectual overhead.

(f) Exams: The activity is relatively inexpensive, however, of the $211.86 total cost, $159.90 is likely to vary with enrolment. This consists of posting and synthesizing grades (Accounts, lines 80 and 81).

(g) TA Meetings: The paid staff meet and evalue TA and ATA performance. As enrolment changes, the amount of TA supervision changes because the necessary number of TAs would change. The relationship should obviously be a positive one.

(h) Clerical Work: We would anticipate little enrolment sensitivity to this function. The secretaries type instructional material and reports, the quantity of which does not depend on enrolment, but on the scope of the course and its related intellectual activities. The amount of duplicating may change with enrolment, but this hardly constitutes much of their workload.

(i) Evaluations: This is the most expensive activity of all. As long as the enrolment is large enough to warrant the development of a management system (and the minimum may be only two to three hundred students), designing it and evaluating its effectiveness probably involves the same principles and the same amount of time whether the enrolment is three hundred or 1200 students. Evaluating the effectiveness of quizzes, seminars, and the course in general is intellectual overhead. Depending upon the amount of data to process, the volume of computer time may vary, but the human resource inputs should not be different from one level of enrolment to another over the relevant range; the organization, planning and execution of the analysis is probably quite insensitive to the amount of data being analyzed, over the relevant range.

(j) Public Relations: This activity consists of communicating the benefits of the system to other staff members and university officials. It also involves hosting visitors who come to Western Michigan to make contact with the system. This is not the kind of activity which depends upon enrolment.

To recapitulate, of all items incurring a total cost amounting to $7666.66, we have reason to believe that no more than $990.82 is likely to vary on account of enrolment.

This means that marginal changes may occur within 12.9% of total cost. We have not estimated the rate at which changes in enrolment reach the 12.9% limit. We sought to demonstrate that minimizing average cost per student in Psychology 150, partly depends upon a relatively large scale of operation, because most of the factors that incur dollar costs are not very sensitive to changes in enrolment. Compared to the largest scale science course accounted in this paper (MGS-FIU 100; CU = $45.81 per semester) the system can operate at about 1/7 the present enrolment before it loses competitive advantage from the purely economic point of view. It can operate at about ½ its present enrolment relative to the simulated traditional structure in line 135 of Table VIII.

We also stated on page 346 above that the low cost of Psychology 150 partly depends upon the economic management of human resources.[45]

The essence of economic resource management is to mobilize student power without paying for it in cash, and to ration all resources such that the jobs consuming more time and requiring less academic experience are performed by more inexpensive labour.

---

[45] It also depends upon a quite low wage rate for the UGA , ($1.50 per hour), though this is not a critical factor.

We document this phenomenon in Table VII

TABLE VII DISTRIBUTION OF WORKLOADS BY RANK

Rank	Pay Rate	Hours/Semester
TA/ATA	CT .024	7352
UGA	$ 1.50	681[46]
Secretary	$ 1.50/3.00	560
GA	$ 4.33	551[46]
Prof.	$ 13.78	218

As unit cost increases, workloads decrease consistently.

As we noted in our discussion of the nature of paid activities, much of it is supervisory and conceptual. The greatest volume of work in the course involves contact with students, helping them and evaluating their work.

---

46. The experience of the past few semesters indicates that the UGA and GA were actually paid for more hours than are recorded here. The explanation is that they spent time "on duty", but not performing any function associated with the course. This involved avoidable expenditures of approximately $1900.00, which the planners now intend to scale down in future semesters, as a result of the present analysis. The amount represents an additional $1.64 per student.

TAs and ATAs perform these jobs. They have had the course. They are selected from the top two hundred in the class, and their competence is carefully monitored by higher grades of staff. TAs and ATAs are paid credit rather than cash for the academic experience they gain in their functions. The reader may verify the nature and time commitment of TA and ATA jobs by examining the Accounts for whichever activities column 14 indicates the use of the TA and ATA.

The course also cashes-in on free goods. Students taking the course instruct each other through their prepared discussions and peer ratings. Furthermore, substantial evaluation of the course comes at no cost by virtue of the M.A. students who submit theses in the field of behavioural psychology on topics involving scientific examination of various elements of the course. For a system of this kind to succeed and maintain high standards, continuous evaluation and quality control is necessary. We have seen that the course planners make much of these activities, with evaluations and controls emanating from students to students, students to staff, staff to students, and staff to staff. It is clear that little of this activity would be feasible unless it were systematic and inexpensive. Psychology 150 meets these requirements.

The accounting exercise we have conducted to this point ignores other economies of Psychology 150 which accrue to Western Michigan University. The present comparison between Psychology 150 and traditional structures compares only direct payouts of one system relative to those of another. We must also consider opportunity costs as they affect the university. An important source of these opportunity costs is the additional fee revenue which accrues to the university from Psychology 150 by virtue of the fact that TAs and ATAs pay for the credit they receive according to the standard rates, but the cost of production of these credits is very low.

We estimate the opportunity costs of Psychology 150 in the following way:

(A) Take the difference in direct cost between Psychology 150 and the traditional structure, and

(B) Add to that the value of the credits attributed to TAs and ATAs, minus the cost difference of producing these credits.

We account for both operations as follows:

Operation (A): Subtract the total cost of Psychology 150 for 1152 students (Accounts, col. 18, line 126) from the total cost of the traditional structure (Accounts, col. 18, line 135). The result is $ 7,979.10.

Operation (B):

(1) Valuation of the Credit: Students normally require 120 credits over 8 semesters to graduate, averaging 15 credits per semester at a fee of $185 per semester, yielding fee per credit of $12.33.

(2) Gross fee Revenue from TA and ATA Credits: Multiply $12.33 by the total credit cost of Psychology 150 (CT 176, Accounts, Col. 18, line 127), yielding gross revenue of $2170.00.

(3) Cost Differences of Credit Production: By this we mean the difference in cost of producing one credit in the traditional structure, as opposed to that of producing one credit by serving as a TA or ATA in Psychology 150. Being very generous to the traditional system, we will assume that on the whole, the cost of production of one credit is similar to that of the simulated traditional structure, (Accounts, line 135). The average cost per student for the three credit

course is $13.58, yielding a cost per credit of $4.53, or $797.28 for 176 credits.

While it may be argued that Psychology 150 incurs costs of producing the credits it gives to TAs and ATAs, the following is also true:

(a) The same costs go toward maintaining quality and running the course, and

(b) In the traditional system, paid teaching assistants and demonstrators should also be supervised.

Since we do not know the extent of supervision in the traditional structure, we assume it is part of the professor's workload as measured in the proxy measure of contact hours. We assume that the implicit cost of supervision in the traditional structure and its explicit cost in the Psychology 150 structure are the same and omit calculating a cost difference here.

The opportunity cost of Operation B consists of the fee revenue which Psychology 150 creates by paying students in credit ($2170.00), plus the saving in production costs of these credits in Psychology 150 relative to the traditional structure ($797.28) yielding a sum of $2967.28

The total opportunity cost is the sum of Operation A+B, yielding an amount of $10,946.38 or $9.50 per student in Psychology 150.

In conclusion, to use traditional structures rather than the Psychology 150 system, the University of Western Michigan would sacrifice resources equivalent to $10,946.38 or $9.50 per student.

We conclude this discussion with a final word about preparation of textbooks for the seminars and the labs. The originality of the course design implied the need for materials that suit its structures, methods and philosophy. One of the major hinderances in course innovation is probably the heavy time commitment and high cost associated with developing new course materials. Psychology 150 met this problem by combining academic industry with commercial entrepreneurship. At different times and for different periods, various authors contributed time to the development of teaching materials. In the case of Dr. Malott's textbook, "Elementary Principles of Behavior", the author made an arrangement with a national textbook publisher to receive an advance on royalties to cover the investment of time in preparation. They assure distribution of the book to Western Michigan students, pending national publication, by marketing a paperback version for little more than printing costs, under the firm name of "Behaviourdelia". Behaviordelia also publishes, "The Big New Mother Mind-Boggling Behavior Expander", as well as other teaching materials associated with the course. The firm provides low cost printed material to the students and earns a small surplus for investment in improvements to old products and the development of new ones. It contracts printing to a Michigan firm using a highly automated photo-offset process to produce good quality at low cost, provided the scale is at a level of at least one thousand copies.

CONCLUSION:

In the foregoing discussion we have sought to demonstrate the proposition that new learning modes may be academically sound and economically feasible. We have also demonstrated that the accounting framework we developed is a useful tool of analysis for both traditional and novel structures.

TABLE VIII "ACCOUNTS" The Psych. 130 System.

SP = Student Participation Tb Total = Distribution of Te Total by CT and $ respectively.
RC = Resource Commitments Pt total = Sum of CT in Col. 18. n = not applicable

FIG 1.

		1 a	2 b	3 d	4 y	5 h	6 Pe	7 e	8 e'	9 e''	10 ß	11 Tb	12 Te	13 l	14 n	15 n	16 SA	17 Pt	18 C	19 CL	20 CA	21 A
Psyc. 130 "Lectures"																						
	SP	14	1	1.0	1	1.0	16.0	1152	288		4	4.0	36									
Schedule Movies, Slide Shows Contact Lecturers et. al.	RC												36 18		GA UGA		1 $ 4.33 1 $ 1.50	36 18	$262.48 $ 42.00			
Lecture Delivery	RC	2	1	1.0	1	1.0		1152	288		4	4.0	8	MALOTT	2		1 $13.78	8	$110.24			
Evaluation (hand-outs and analysis)	RC	14	1	4.0	1	4.0		1152	1152		1	4.0	36		TA		1 CT .024	56	CT 1.3			
	TOTALS											[illegible]	[illegible]					CT 1.3	$[illegible]	$ [illegible]	$ [illegible]	.02
Psyc. 130 "Seminars"																						
	SP GR. A.	7	1	.66	4	2.64	18.3	376	24	4 f	24	63.4	444		PEER		NIL		NIL	NIL	NIL	NIL
	SP GR. B.	7	1	.66	4	2.64	18.3	376	24	4 f	24	63.4	444		PEER		NIL		NIL	NIL	NIL	NIL
	A + B	14						1152				126.8	888									
Monitoring & Tables of A	RC	14	1	.66	4	2.64					24	126.8	888		TA		1 CT .024	888	CT 21.3			
Eval. & Posting Peer Ratings	RC	14	1	.25	4	1.0					24	24.0	336		TA		1 CT .024	336	CT 8.1			
Monitoring of GA Performance	RC	14	1	.66	4	2.64					6	15.84	222		ATA		1 CT .024	222	CT 5.3			
Monitoring of Equipment	RC	14	1	.083	4	.33					24	7.92	111		UGA		1 $ 1.50	111	$166.50			
Monitor Peer Ratings & ATA's																						
Equipment. Material Design-Editing	RC	13	1	10.0	1	10.0					n	10.0	130		GA		1 $ 4.33	130	$649.50			
Monitor GA, Design, Plan, Evalue	RC	13	1	15.0	1	2.0					n	2.0	30	MALOTT	2		1 $13.78	30	$413.40			
	TOTALS RC											[illegible]	[illegible]					CT 34.7	$[illegible]	$ [illegible]	$ [illegible]	[illegible]
Psyc. 130 "Labs"																						
	SP GR. A.	7	1	.66	4	2.64	18.3	376	24	1 f	24	63.4	444									
	SP GR. B.	7	1	.66	4	2.64	18.3	376	24	1 f	24	63.4	444									
	A + B	14						1152				126.8	888									
Monitor & Assist Students	RC	14	1	.66	4	2.64					24	126.8	888		TA		1 CT .024	888	CT 21.3			
Monitor & Assist TA	RC	14	1	.66	4	2.64					6	15.84	222		ATA		1 CT .024	222	CT 5.3			
Check equipment, exp. work, Animal Behaviour	RC	14	1	.17	1	.17					24	4.08	57		UGA		1 $ 1.50	57	$ 85.50			
Order Rats, Equipment & Maintenance	RC	13	1	1.3	1	1.3					n	1.3	22.5		UGA		1 $ 1.50	22.5	$ 33.75			
Monitors UGA Performance	RC	13	1	.5	1	.5					n	.5	7.5	MALOTT	2		1 $13.78	7.5	$103.35			
Grade Lab Reports	RC	14	1	.71	1	.71					24	17.0	238		TA		1 CT .024	238	CT 5.7			
Make-up Labs & Eval.	SP & RC	14	1	1.0	1	1.0	14.0	80	20		4	4.0	36		TA		1 CT .024	56	CT 1.3			
	TOTALS RC											304.87	1491					CT 33.6	$222.60	$ .39	$ .23	$ .0[illegible]

FIG 1

2.

			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
			a	b	d	f	h	Pe	e	f'	f''	g	Tb	Ta	l	m	n	SA	PS	C	CC	CS	A
38	**Func. 130 "Quizzes"**																						
39																							
40	Quiz Administration	SP	14	1	.17	4	.68	9.52	1152	25		48	32.64	457.0									
41	Grading, Posting, Student Interact	RC	14	1	.17	4	.68					48	32.64	457.0		TA	1	CT .024	457.0	CT 11.0			
42	Feed Quiz to TA, Monitor Quiz Admin.	RC	14	1	.33	4	1.32					48	63.36	888.0		TA	1	CT .024	888.0	CT 21.3			
43	Student Interact, Assist & Monitor Grades	RC	14	1	.083	4	.33					48	15.84	232.0		ATA	1	CT .024	232.0	CT 5.3			
44	Monitor Quiz Admin.	RC	14	1	.17	1	.17					12	2.04	28.5		UGA	1	$ 1.50	[illegible].5	$ 42.75			
45	Student Interaction Monitor Grading	RC	14	1	.042	4	.168					48	8.0	112.0		UGA	1	$ 1.50	112.0	$168.00			
46	Monitor Quiz Grading	RC	14	1	.25	1	.25					*	.25	3.5		GA	1	$ 4.33	3.5	$ 15.15			
47	Monitor Quiz Admin.	RC	14	1	.5	1	.5					*	.5	7.0		GA	1	$ 4.33	7.0	$ 30.30			
48	Monitor GA. Quiz Monitoring	RC	14	1	.25	1	.25					*	.25	3.5	MALOTT	2	1	$13.78	3.5	$ 48.23			
49	Schedule Quiz Questions/Semest.	RC	1	1	10.0	1	10.0					*	10.0	10.0		GA	1	$ 4.33	10.0	$ 43.30			
50	Depreciated Inv. in Quiz Development/Semest.	RC	1	1	33.3	1	33.3						33.3	33.3		GA	1	$ 4.33	33.3	$144.19			
51	Depreciated Inv. in Quiz Development/Semest.	RC	1	1	16.7	1	16.7						16.7	16.7		UGA	1	$ 1.50	16.7	$ 25.05			
52	Revision of Bad Questions	RC	1	1	12.5	1	12.5						12.5	12.5		UGA	1	$ 1.50	12.5	$ 18.75			
53	Error Analysis Dept.Semest.	RC	1	1	50.0	1	50.0						50.0	50.0		TA	1	CT .024	50.0	CT 1.2			
54																							
55	TOTALS												3817 227	[illegible]					CT 38.8	$ 535.72	$ .47	$ 1.37	$ .03
56	**Func. 130 "Remediation-Require"**																						
57																							
58	Assist. Remediation, Admin. Quiz	SP	14	1	1.0	4	4.0	38.0	[illegible]	40		5	20.0	280.0									
58	Assist. Remediation, Admin. Quiz	RC	14	1	1.0	4	4.0					5	20.0	280.0		TA	1	CT .024	280.0	CT 6.7			
59	Assist. Remediation, A[illegible] in. Quiz	RC											20.0	280.0		TA	1	CT .024	280.0	CT 6.7			
60	Assist. Remediation, Admin. Quiz	RC											20.0	280.0		TA	1	CT .024	280.0	CT 6.7			
61	Assist. Remediation, Admin. Quiz	RC											20.0	280.0		TA	1	CT .024	280.0	CT 6.7			
62	Grading, Posting	RC	14	1	.33	4	1.32					5	6.6	92.0		TA	1	CT .024	92.0	CT 2.2			
63	Grading, Posting	RC											6.6	92.0		TA	1	CT .024	92.0	CT 2.2			
64	Grading, Posting	RC											6.6	92.0		TA	1	CT .024	92.0	CT 2.2			
65	Grading, Posting	RC											6.6	92.0		TA	1	CT .024	92.0	CT 2.2			
66	Feed Quest; Stud. Interact; Monitor Grades	RC	14	1	.25	4	1.0					5	5.0	70.0		ATA	1	CT .024	70.0	CT 1.7			
67	Interact With Students	RC	14	1	.17	4	.68					5	3.4	48.0		UGA	1	$ 1.50	48.0	$ 72.00			
68	Dept. Inv. in Quiz Devel/Semest.	RC	1	1	25.0	1	25.0						25.0	25.0		UGA	1	$ 1.50	25.0	$ 37.50			
69	Dept. Inv. in Quiz Devel/Semest.	RC	1	1	25.0	1	25.0						25.0	25.0		GA	1	$ 4.33	25.0	$108.25			
70	Dept. Inv. in Quiz Devel/Semest.	RC	1	1	1.7	1	1.7						1.7	1.7	MALOTT	2	1	$13.78	1.7	$ 23.43			
71	Error Analysis Dept.Semest.	RC	1	1	8.3	1	8.3						8.3	8.3		TA	1	CT .024	8.3	CT .2			
72																							
73																							
74	TOTALS												[illegible]	[illegible]					CT 37.5	$ 241.18	$ .87	$ .93	$ .7[illegible]

```
                                                                                                              3.
                                                                                                  19    20    21
                                   1   2   3   4   5   6    7   8   9  10  11   12   13  14  15  16    17   18   CU    CB    A
                                   a   b   d   7   h   Fe   e   e°  c°  B   Tb   Te   1   e   e   SA    Pt   C
            FIG    1                  1  1.0   1  2.0  1132 1[illegible]    4  6.0  18
75 Part. 130 "Exams"          BC   1                                         12          GA     1 $ 4.33   12.0 $ 51.96
76 Write 2 Exams/Semest.      BC   1                                         14          TA     1 CT .024  14.0CT   .3
77 Test Scores                BC   1                                        100          TA     1 CT .024  100.0CT 2.4
   Synthesize/Post Terminal                                                  10          ATA    1 CT .024  10.0CT   .2
78 Grades                     BC   1                                         20          UGA    1 $ 1.30   20.0 $ 30.00
79      "        "            BC                                             30          GA     1 $ 4.33   30.0 $ 129.90
80      "        "            BC   1                                                          CT  2.9 $ 211.[illegible]   [illegible]   .03
81                    TOTAL   BC                                   [illegible]  186
82                                                          10   10.0   700          TA     1 CT  .024  700.0CT 16.8
83 Part. 130 "TA Meetings"         14   1   1.0   1   1.0   12   12.0   168          ATA    1 CT  .024  168.0CT  4.0
84 Meet and Do Quiz           BC   14   1   1.0   1   1.0    4    4.0    56          UGA    1 $ 1.50    56.0 $ 84.00
85 Meet and Do Quiz           BC   14   1   1.0   1   1.0    3    3.0    42          GA     1 $ 4.33    42.0 $ 181.86
86 Meet and Evalue            BC   14   1   1.0   1   1.0    3    .51     7          GA     1 $ 4.33     7.0 $ 30.31
87 Meet and Evalue            BC   14   1   .17   1   .17     [illegible]  973         CT 20.8 $ 2[illegible]   [illegible]
88 Preparation                BC   14
89                    TOTAL   BC                                  1.5    21          TA     1 CT  .024   21.0CT   .5
90 Part. 130 "Central Excuse System"  14   1   1.5   1   1.5      2.0    28          UGA    1 $ 1.50    28.0 $ 42.00
91 Processing 35 excuses/wk.  BC   14   1   2.0   1   2.0  [illegible]  49                  CT  .5 $ 42.00 $   .[illegible]
92      "      "     "   "    BC
93                    TOTAL   BC                                  20.0   280        PT SEC  1 $ 3.00   280.0 $ 840.00
94 Part. 130 "Clerical Work"       14   1   4.0   3   20.0       20.0   280        PT SEC  1 $ 1.50   280.0 $ 420.00
95 Typing and Filing          BC   14   1   4.0   3   20.0        560   560                     $1260.00 $  1.[illegible]
96 Typing and Filing          BC
97                    TOTAL   BC                                         25          TA     1 CT  .024   25.0CT   .6
98 Part. 130 "Staff Recruitment"   1                                     40          UGA    1 $ 1.50    40.0 $ 60.00
99 Find-Encourage Best Students BC 1                                      5          GA     1 $ 4.33     5.0 $ 21.65
100 Interact With Nominees    BC   1                      [illegible]    70                       [illegible] $ 81.65 $   .02
101 Selection                 BC   1
102                   TOTAL   BC                        e   15.0   675           GA       THESIS    675.0  NIL     NIL   NIL   NIL
103 Part. 130 "Evaluations"        43   1   15.0   1   15.0   e   15.0   675           GA       THESIS    675.0  NIL     NIL   NIL   NIL
104 Evalue Seminar Utility    BC   43   1   15.0   1   15.0   e    1.0    43  MALOTT   2     1 $13.78    45.0 $ 620.10
105 Quiz Evaluation (Overall) BC   43   1    1.0   1    1.0                100           TA     1 CT  .024  100.0 CT  2.4
106 Quiz Evaluation (Overall) BC   1                                      20           UGA    1 $ 1.50    20.0 $ 30.00
    Student Course Evaluation:                                            10           GA     1 $ 4.33    10.0 $ 43.30
107 Admin./Analysis.          BC   1                                          2 MALOTT   2     1 $13.78     2.0 $ 27.56
108     "        "            BC   1
109     "        "            BC   1
110     "        "
111
```

	FIX	1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
			a	b	c	d	h	Pn	e	n'	n''	R	Nb	Ta	I	s	D	$R	Ps	C	CC	CR	A
112	Overall Analysis, Design Planning	BC	14	1	4	1	4						4	38		UGA		1 $ 1.50	38.0	$ 84.50			
113	" "	BC	18	1	10	1	12						10	140		GA		1 $ 4.22	140.0	$606.20			
114	" "	BC	16	1	5	1	5						5	70	MALOTT	I		1 $13.78	70.0	$ 964.60			
115	**TOTAL**	**BC**											**28 342**	**1393**					**GT 2.4**	**$2215.30 $**	**2.38**		
116	**Psyc. 130 "Materials Development"**												PME 1150										
117	Slide Show (1)	BC	1											3000		MISC		NIL	3000.0	NIL	NIL	NIL	NIL
118	Slide Show (2)	BC	1											100		TA		1 CT .036	100.0	CT 3.6			
119	Slide Show (3)	BC	1											25		TA		1 CT .024	25.0	CT .6			
120	**TOTAL**	**BC**											FREE **125 3000**	**3125**					**CT 3.0**	**NIL**	**NIL**		
121	**Psyc. 130 "Public Relations"**																						
122	Faculty-Admin. Interest	BC	1											50	MALOTT	I		1 $13.78	50.0	$ 689.00			
123	Greeting Visitors	BC	1											20		GA		1 $ 4.33	20.0	$ 86.60			
124	**TOTAL**	**BC**											**30**	**70**						**$ 775.60 $**	**.02**		
125																							
126	**GRAND TOTALS**							**60.1**						**GT 2307**						**1944.46 $**	**4.62 $**	**2.98 $**	**.11**
127														**BC 11713**						**CT336.0**			
128													PAID CT	7352									
129													PAID $	2010									
130													FREE	2350									
131	**A Traditional Structure**																						
132	Psyc. 130 Lectures		14	1	1	2	2	28	2152	288		4	8	112	PROF	I	336	11000	.333	4000.00 $	3.47 $	35.72 $	.12
133	Psyc. 130 Tutorials		7	1	1	1	1	7	2152	24		48	48	336		GA		1 $ 8.66	336.0	2 909.76 $	2.33 $	9.46 $	.36
134	Psyc. 130 Labs		7	1	1	6	6	28	1152		24	48	192	1344		GRH		1 $ 6.50	1344.0	8 736.00 $	7.58 $	6.50 $	.27
135	**TOTALS**							**63**						**1792**						**15651.76 $**	**13.38 $**	**8.71 $**	**.32**
136																							
137																							
138																							
139																							
140																							
141																							
142																							
143																							
144																							
145																							
146																							
147																							
148																							

Teaching Apprentice Duties or "How will I be graded?"

It is the Psych 150 policy to define as clearly as possible the duties and obligations of students, TAs, ATAs and assistants. The following is a list of duties, which you as TAs will be expected to perform to the best of your abilities. The number beside each task indicates the number of points you will lose if that task is not completed. If for some reason you feel that you have a rational explanation for not completing some assigned task, you must present your case, either verbally or written to the assistant on duty. Excused absences from class must be verified in the same manner as 150 students follow and will be considered by Kathy Jenczarek, your local Graduate Assistant.

DUTY	POINTS LOST FOR NOT COMPLETING DUTY	TOTAL
A. **General Attendance Obligation**		20 pts.
1. Tuesday night meeting (quiz)	5 pts.	
2. Your own class	5 pts.	
3. Remedial I	5 pts.	
4. Remedial II	5.pts.	
B. **General Duties During Lab and Seminar**		13 pts.
1. Promptness	2 pts.	
2. Grades posted and up to date (including posting numbers on make-up board)	3 pts.	
3. Classroom clean including Skinner boxes and cubicles on table and no smoking	2 pts.	
4. Quiz handled effeciently (correct questions, minimal time, etc.)	1 pts.	
5. Class control (minimal noise level, not dismissing class early)	1 pts.	
6. Quiz graded correctly	1 pts.	
7. Doors closed at beginning of class and lights on and off at appropriate times	1 pts.	
8. Answering students questions	1 pts.	
9. Checking with your ATA and assistant before leaving	1 pts.	
C. **Specific Lab Obligations**		11 pts.
1. Proper rat care including watering, feeding, changing papers and changing racks.	2 pts.	
2. Proper dispensement and returning of rats	1 pts.	
3. Helping students in class	1 pts.	
4. Weekend rat lab care	5 pts.	
5. Grading and handing back of lab reports	1 pts.	
6. Fans on in room during lab time	1 pts.	
D. **Specific Seminar Obligations**		9 pts.
1. Proper rotation	1 pts.	
2. Correct seating (at least 3 at a table)	1 pts.	
3. Discussion begin s by 15 min. after hour	1 pts.	
4. Timer used	1 pts.	
5. Random number schedule followed	1 pts.	
6. Correct monitoring of discussions	2 pts.	
7. Incorrect grading consequated	1 pts.	
8. 35-40 min. of seminar each day	1 pts.	

TA MONITORING SCHEDULE
284 A

WEEK	DAY	TABLE#
2	W	6
	Th	4
3	M	1
	T	3
	W	2
	Th	5
4	M	3
	T	1
	W	6
	Th	2
5	M	4
	T	3
	W	5
	Th	1
6	M	5
	T	6
	W	2
	Th	4
7	M	1
	T	3
	W	6
	Th	2
8	M	4
	T	5
	W	2
	Th	6

Note: If the table you are to monitor is the honor's table (no headsets) use that day to listen to tables where discussions were not good to facilitate ranking at the end of every two weeks.

TA MONITORING SCHEDULE
B

WEEK	DAY	TABLE#
2	W	1
	Th	5
3	M	6
	T	4
	W	3
	Th	2
4	M	1
	T	5
	W	2
	Th	4
5	M	3
	T	1
	W	6
	Th	2
6	M	5
	T	3
	W	1
	Th	4
7	M	4
	T	6
	W	3
	Th	5
8	M	1
	T	5
	W	2
	Th	6

Note: If the table you are to monitor is the honor's table (no headsets) use that day to listen to tables where discussions were bad to facilitate ranking at the end of every two weeks.

CHAPTER FOUR

THE POLICY VALUE OF THE ACCOUNTING SYSTEM

In this chapter we relate the technique described in the previous chapters to the kinds of purposes it may serve.

We open with two general problems:

(1) The present exercise is a first approximation to the measurement and costing of output in that it only measures contact hour workload of teaching staff, it says nothing about other instructional activity, capital investment, space allocation and costs, support services such as non-academic staff, administration, library, audio-visual, and other equipment. It is therefore helpful in costing the allocation of academic staff for the teaching activities we measure. It would be much more useful were it a constituent element of a general plan, which would include all the areas it presently excludes. Further effort to expand the model would be useful; once we build the general system, possibilities of trade-offs between various categories of resources and their alternative costs may be approached rationally. It may then appear, for example, that a favourable solution according to existing analysis may be less satisfactory when

other factors are considered as well. We therefore hesitate to urge immediate implementation of this system of analysis in its present state as the sole criterion for deciding current policy issues. Policy makers should find it a useful contributory element to discussions involving programme costing, as long as they use it in conjunction with whatever material they can marshal to fill in the missing links.

(2) The second problem is that use of the planning model raises the question of change in the distribution of the power to decide.

The adoption of the systematic procedures of decision-making introduces a new way of thinking that inherently changes the character of university decision procedures. Facts, figures and structured statements relevant to the physical and financial inputs and outputs of different programs replace or complement intuition and less rigorous exposition of resource utilization factors. Like many other scientific instruments, the planning model is not neutral in terms of its use. Non-neutrality arises on the questions of who uses the techniques and to what ends. With techniques of this kind, decisions depend upon analysis of the facts in relation to decision criteria that are consistent with the outputs of the accounting techniques. Therefore, were the model to become an important basis of decision making, only those people who know the facts, the concepts and the approach may be in a position to effectively make decisions.

The planning model may therefore be an instrument of exclusion or of participation in decision-making procedures of the institutions, depending upon who has access to the model as well as control over the variables that it includes. The explicit accounting of a series of variables for general planning purposes opens the question of which variables are set by which people. It is convenient to discuss this matter in the context of the different arenas where resource utilization problems may be considered: (a) Intra-university, (b) Inter-university, and (c) Extra-university.

This breakdown is a matter of analytic convenience. It is clear that constraints emanating from one level may influence the kind of decisions that can be made at other levels. Indeed, anyone filling in the empty boxes of the accounting sheets must be aware of constraints over which he has little control. We believe that the substantial area of decision-making procedures deserves independent study. The following remarks introduce the subject in order to situate the kinds of things the accounting framework may be called upon to do.

(a) Intra-university decisions:

The accounting framework facilitates a systematic exposition of the following variables relevant to an instructional program: the kind and number of programs and program elements to be offered, the number of students enrolled in each, the number of meetings for each, class sizes, level and time commitment of staff responsible for the program, and salaries of staff.

Questions arise as to who decides which of these variables, and by what criteria. What things do students, professors or administrators decide, either alone or jointly? What political organization characterizes the use of the accounting framework?

We suggest as a general principle that structures need not necessarily change as a result of the introduction of new accounting procedures as long as the same bodies who contributed to the decisions in the past can work with the new data formats. In this way the traditional parties to the issues discuss them within the same frame of reference. The distribution of influence and power is bound to be affected by any deviation from this principle simply because those people who have privileged access to the information (which constitutes the basis of decision), are in a better position to argue their case within the new framework, that is so heavily information-oriented.

For example, we can see that both students and staff would be interested in pedagogic matters such as the type, number and organization of activities, class sizes, frequency of meetings and the kind of teaching staff committed to the various activities. Professors may be particularly interested in their workloads and their salaries, while students may be particularly concerned about pay rates for demonstrators, teaching assistants, and other positions filled by students. The university accountants may be most concerned with total, average, or marginal costs. Thus, we foresee the possibility that some variables in the accounts are of joint interest, while others may be of more particular interest to some but not others. To the extent that all variables are interdependent and to the extent that they are seen and understood in that light, the accounting framework may be viewed as a useful reference around which to discuss pedagogic and financial issues of general concern among different university bodies.

(b) Inter-university decisions:

At the inter-university level the accounting framework invites program and cost comparisons of the sort we have attempted in Chapter III, Section III. Analysis of accounts data inform on the structural features of teaching different programs in different universities that account for the fact that some are more expensive than others. For example, we should expect higher total costs of running one department relative to another if the former has more courses, smaller classes, higher salaries, more expensive staff and lower workloads than the other. It may be that the more expensive department is more economical with regard to some of these factors, but very much costlier with respect to others. A priori statements are difficult to make about which variables are most critical to cost. Our initial analysis of four departments has suggested some, however, these results would require analyses with more data before reasonably confirmed hypotheses emerge.

Inter-university bodies may be interested in the question of normalization between universities. Questions arise as to what can and should be normalized, and how. Normalizing average cost per student for any one program would involve normalization of contributory factors at least to the extent that any feasible combination of variables yields average costs that satisfy the conditions of the norm. There are as many degrees of freedom in this process as there are endogenously determinable values to the variables that yield costs. It may be that cost normalization is either impossible or undesirable relative to surrounding economic and pedagogic considerations that could maintain in any university. The accounting framework is one tool of analysis by which to pinpoint what is inter-institutionally comparable and feasible to normalize, normalize within certain limits, or not normalize at all.

Another question of inter-university concern may be that of resource rationalization between them. Resource rationalization may take the form of shared programs or shared elements of programs. Universities may find it economic not to develop competitive programs or program elements, but transport the students to the program rather than the program to the students. The accounting framework will help to pinpoint answers to questions that inevitably arise in such an exercise: (a) what would be the inputs and institutional costs of running separate programs, and (b) what would be the inputs and institutional costs of running shared programs? In reality, we should account the cost of student displacement in such exercises. We may simulate each alternative situation and select the one that yields the lowest cost per student (subject to conditions of pedagogic pallatibility). Although our present model does not consider cost of student displacement, were this factor accounted, decision-makers would have to consider change in cost to the institution, to the student, and the form of cost re-distribution that would be economic and acceptable to both. We believe that sensible decisions on resource rationalization would require widespread involvement of different kinds of expertise. Students and staff should be very interested in the instructional aspects of a joint program, and their views could influence program structures which have financial implications for the financial officers of the universities. The use of scientific decision-making procedures could therefore encourage new kinds of co-ordination between interested parties within and between the universities involved, or it could discourage co-operation if unilateral or otherwise exclusive decision-making procedures are implemented.

(c) Extra-university decisions:

In situations where universities are heavily financed out of the public purse, two rather delicate issues arise that are important to the techniques of financial decision making.

The first of these issues is that universities and the public expect the government to contribute substantial and rapidly increasing amounts of money to finance university activities. In some way, the government is ultimately accountable to the public for how it spends public funds. It must justify to public satisfaction that the distribution of public monies between competing social programs is a reasonable one. Therefore, we may presume that the government is unlikely to subsidize the universities without some rationale or criterion to justify the amount of the subsidies. To defend itself from charges of erroneous allocation, the government may take the position that university claims for subsidization should be well documented with the facts that facilitate an assessment of the extent *to which university* requests are "justifiable". The serious problem is that of defining "justifiability". It can involve many things: the justifiability of a program itself, or that of its claim to resources and consequent consumption of funds.

The second issue is that universities may wish to claim a rather independent status within the society— not because they object to public responsibility, but because the search for knowledge and truth often requires activities and methods with which the public is either unfamiliar, or to which it may even exhibit short-run disapproval. Disapproval could be the result of unfamiliarity, or of hesitation to finance activities which question certain habits and ideas of the society. Yet this the universities may consider to be an important element of their social responsibility. The universities may be hesitant to stake their claim for funds on the basis of program requirements presented in the format of a program budget, because this kind of presentation invites a detailed public scrutiny of programs and their related costs that universities may consider potentially harmful to the cause of unfettered teaching and research.

It appears that there exists a dilemma of acquiring the necessary funding in a way that neither compromises the freedom of the universities, nor dissatisfies the public concern for judicious expenditure.

One way of circumventing this dilemma is that of resorting to formula finance. An example of an operating system of formula finance is that in use in the Province of Ontario. The province grants each university a total sum determined by subtracting student fee revenue from an amount calculated by summing the number of basic income units in the institution and multiplying that quantity by the value of the basic income unit.

The various categories of students are accorded differing numbers of basic income units, the number depending upon the level and discipline of the student. The value of this number is determined by cost analysis and short-run cost projections. While the system accords special financial consideration to "emerging universities", in general it funds a university on the sole criterion of the number and kind of students it accepts. The universities are free to spend their grants as they see fit.

An advantage of the formula from the university point of view is also one of its disadvantages from the public point of view: it protects the universities from public scrutiny of internal allocation, and this is probably satisfactory to the universities. But at the same time it is a veil that effectively inhibits the public from developing a detailed understanding of how the university spends its funds. It does not know, except in very general terms, what kinds of teaching, research and public service cost how much money, nor does it have any way of assessing the efficiency of producing these outputs. While it could be argued that the public does not need a program by program account of how the universities spend their money, it is becoming difficult to defend this position: public expenditure programs are ultimately substitutable goods, and society views the university more and more as a public service institution rather than a private preserve of the intellect. The development of this "multiversity" ideology coincides with the growth of public and corporate support of university activity, from the Middle Ages onward.[1]

The authors of the Ontario formula believe that since the general basis of entitlement to funds is the same for everyone, the formula has the substantial advantage of equity. We do not subscribe to this view because it does not adequately dispose of the problem of equity. It assumes that equity consists of uniform entitlement criteria, though it makes the exception of "emerging universities". The exception belies the general case. In what way can it be denied that all universities are changing and "emerging" in different ways?

It seems to us that the subsidization problem is really a welfare problem, of which "equity" is one part and efficiency another. We hypothesize that the subsidization problem would be adequately solved if grants were both equiable and efficient. We hypothesize further that equity is observed if the grant meets the autonomously defined need of each institution. This hypothesis is nothing more than a confirmation of Paretian welfare criteria whereby the individual is the sole judge of his own welfare, slightly

---

1. Kerr, Clark, The Uses of the University. Harper and Row, 1966. Ch. 1.

modified to read: "The institution is the sole judge of its own welfare." We do not believe that this welfare criteria is anti-social, as long as we assume that no institution in this day and age can resist the co-option of various "social objectives" in the definition of its own needs.

The Ontario notion of equity may be incomplete in the welfare sense, because uniform entitlement criteria may not satisfy difference in need that could exist between the institutions. To the extent that institutions redefine their conception of need to conform to the norms of the formula, we cannot be sure that the formula maximizes welfare, because welfare is no longer an independent variable.

Needs between institutions differ because of two problems which we refer to as "divergent development" and "extra-formula situations".

The divergent development problem is that given a history of relatively independent development, costs per student between different universities may be quite dissimilar, and the attempt to establish expenditure norms could contain built in inefficiencies of over-financing some institutions and under-financing others, relative to an autonomous definition of need.

Extra-formula situations arise when some kinds of expenditure are difficult to allocate according to normalized criteria. Either the expenditures are tied to circumstances that are particular to one or several institutions, or in some cases the variables that account for substantial divergences around a norm are too complicated to be incorporated into a formula at this stage of its development.

The efficiency problem is not completely divorced from that of equity. Inefficiency arises when the supply and demand for funds are out of equilibrium, when demand becomes a function of supply, or when supply becomes a function of demand.

Disequilibrium between supply and demand for funds arises when norms create over-financing in some institutions and under-financing in others. We suggested that this situation is not only inefficient, but inequitous as well. It is inefficient because it creates waste in some places and deficiencies in others. It is inequitous because it provides differing levels of welfare which could be corrected by redistribution.

Demand could become a function of supply when the supply criteria elicit behaviours that the institutions would otherwise avoid. For example, suppose that "financial ease" is an objective of university administrations. We know that the formula may not fund each category of student accurately in each institution, because not all institutions spend the normalized amount per student. For whichever category there may exist a positive differential between formula granted revenue and actual cost per student, the universities may be tempted to either moderately redefine student categories to reclassify some students from lesser to better paying categories, or they may expand enrolments in those categories that maximize income relative to expenditure.

Supply could become a function of demand if the formula does not build in factors that reward technical efficiency or penalize technical inefficiency. The amount the formula subsidizes the university depends, for one thing, on the value of the basic income unit and on the number of basic income units. Some statistical investigation is obviously necessary to determine an agreed value for this basic income unit. The statistical investigation uses past data. Past behaviour then becomes an institutionalized criteria of future behaviour. Therefore, an averaged value of past inefficiencies of all the institutions, augmented by inflators for the usual kinds of cost inflation that occur from year to year, becomes the general norm for financial allocation. The same is true for the procedure of attributing an amount of basic income units to each category of students. Of course, these values may be modified from year to year as experience may indicate gross inaccuracies in one category or another. But how often this may happen in both directions is an open question. It is easy to use extra revenues, more difficult to cutback.

Supply becomes a function of demand in the sense that the formula funds amounts of money that are justifiable in terms of the formula, but the formula may not be justifiable in terms of behaviour that is technically efficient. By "technical efficiency" we mean "procedures that reach objectives by the least costly of all acceptable techniques". There is no reason to assume that past behaviour is necessarily the most efficient, yet it is a criteria of financing because the formula reflects what the universities have been doing , on the average, and nothing inheres in the formula to encourage change except by accident of disequilibrium between supply and demand for funds.

The sum of the argument is that the Ontario-type formula may lack relevance to particular institutions and it does not necessarily lay the basis of efficient financing. Perhaps its inaccuracy and inefficiency may be overcome by building more discriminating formulae, the construction and values of which derive from extensive pedagogic and extra-financial analyses and planning. To the extent that extra-university organisms are involved in this process, the formulae will not overcome the dilemma between privacy and financial dependence.

The Ontario approach is not the only way of financing by formula. We cannot say a priori whether or not formula finance is capable of yielding equitable and efficient subsidies. What we can discuss a priori are the requirements of research into this question. We believe that formulae cannot be determined in the absence of cost analysis and program planning. Thus, whether the system of financing the universities will be formula-based or not, the analysis and the planning will have to be undertaken. The universities owe this to themselves, to be as economic in the attainment of their objectives as they can within the bounds of acceptability to the academic community. There are innumerable ways of building formulae, and depending upon the specifics of each situation, they may preserve the status quo, or they may re-allocate, and they may be constructed to re-allocate by any criteria the allocators choose.

The conclusion of this line of argument is that formula finance is not necessarily a guarantee against extra-university intervention, nor is it necessarily equitable or efficient.

Functionally, the university is a public institution. Like other public institutions, we may argue that the university requires public supervision. However, supervision of the university is complicated by the fact that one of the goods the public buys in supporting universities is freedom. The act of buying the goods should not destroy them.

Rather than arguing for or against public involvement in the life of the university, we suggest that a more rational approach may be to delineate the nature and extent of public involvement in a way that neither compromises the university's freedom of enquiry, nor eliminates the public from its vital concern of what the university contributes to the society.

We suggest that this procedure is better than one of publicly controlled formula finance, where neither freedom nor efficiency is guaranteed.

The form that public involvement may take could be as follows:

One: The granting agency absolves itself from all concern with the distribution of funds between existing institutions. It places an amount at the disposition of the universities and they create distributive mechanisms and policies with which they live. Between them they may distribute by PPBS, or they may determine a formula approach that they deem equitable and efficient.

Two: The granting agency absolves itself from any immediate concern with cost analysis at the university level. Of the total amount of funds available from the public purse, the public makes a decision about the quantitative value it attaches to the university sector. In this respect, the question is: "How much do we value universities as opposed to roads, health and welfare, non-university education, etc.?" The grant would then explicitly reflect public priorities. None of this prevents the universities from seeking funds from anywhere else they see fit. It is then the responsibility of the universities to spend their monies as efficiently as they can. They may inform the public of the cost of graduating a student in any program, once they have done their homework.

Three: The public may use these figures as the supply element to consider in the evaluation of the university sector. The demand element would consist of the demand for university graduates as expressed by government, business, other individuals and the university sector itself. When demand is matched with supply cost, a total grant emerges. In this way, the public has a definite say in the quantity of graduates per discipline that the university produces.

Four: While university and non-university persons may have an interest in collaboration on the question of program content, the distinction between collaboration and coercion is essential to maintain.

In the context of this kind of decision making, extra-university sources would not come into intimate contact with tools of financial analysis and program planning (such as those developed in this paper). Extra-university sources would trust that the universities themselves use the tools to make efficient pedagogic and financial decisions. In this connection, the discretion afforded the university is not different than that accorded all other undertakings, both private and public. It rests on the premise that on the whole, the institution is its own best judge on matters of efficiency, and will interact with other elements of society to satisfy demand.

We know that this premise is a very questionable one--it is by no means clear that maximization of consumer welfare is the primary objective of either certain businesses or certain governments, but as long as the principle of plurastic social organization is preferred to one of

APPENDICES

central planning, there is no justification to submit universities alone to centralized public scrutiny. This is especially important in the context of the substantial claims to academic freedom that the institutions maintain, and the very severe difficulties that non-university people may experience in guiding the universities on issues of technique and efficiency, with which the universities themselves are now beginning to grapple.

APPENDIX I

by DONALD KINGSBURY

A MATHEMATICS LEARNING CENTER: For Educational Revolution

We have 6,000 mathematics students in our kingdom. They harvest the wheat with scythes and thrash out the chaff with sticks, and grind the wheat between stones late into the night. Only in May when the summer sun comes, do you see our math students laughing and rolling in the grass with their fair maidens. Good peasants they are, uncomplaining of their hard and meager life, grateful for the odd boar's foot thrown into their stew, sullen perhaps, but not given to insolence like the thievish peasants of some yonder kingdoms. One can hardly expect a noble light in the eyes of such ox-like folk. But I am not among those who attribute their dullness to base birth. They spend long hours to gain little and their gruel lacks the spice by which the mind is stimulated to thought and manly action.

For reasons I cannot account and ledger, they move my pity whenever I have an idle moment. I am the youngest son of the feudal lord. I sit among the tapestries that keep the walls warm, and the fire in the hearth is extravagant, and I tear apart meat steeped in Indies spices, and there are dancing girls and jocund knights to keep me company. Why should I be rich and our math students so wretched?

My thoughts tonight are upon a child of math I met while upon horseback in the village, an empty faced child with bloated belly who will for certain grow up to be nothing but a knave. My brothers say, "God wills it so. Pray brother; put your mind at rest with thoughts of the glory of God."

And I kneel and pray before my crucifix but see only in the tortured face of Christ a math student trying to understand the epsilons and deltas of the limit definition.

Quebec gave me a small purse for a year's travel and meditation. I took myself far away to the Southern Empire in a giant airplane with howling pods on the wings. I studied with Brethower and Rummler and Markle. There was much to be learned. I went to the far sea and talked with many people. It all settled on me slowly.

Only now am I ready to act on behalf of the peasants. I am convinced of the rightness of my proposals. This is what must be done.

Necessities

1. Any project to improve the learning conditions of the math students must be started on a small pilot-plant scale, and run on a pilot-plant scale until the major problems introduced by the changes are so well understood that a larger program can be initiated with the certainty of success.

2. Courses which have a linear syllabus that starts in September and ends in April must be abolished in the project. There is no evidence that students (or staff) can make a rational decision in September about mathematical needs for a full year. There is evidence that a linear sequence over which the student has no control destroys motivation, interest, competence, and initiative.

3. To maximize the learning/effort ratio, evaluation must occur whenever the student requests it and credit must be given for effort the instant competence is reached.

4. There must be a continuous advice service which adequately matches students needs to subject material. A student must be free to change his math goals at any time, as new circumstance or experience dictates.

5. Teaching material should be constantly under revision by learning materials engineers, the revision being based on feedback from student failures. This will ensure that the operation becomes progressively more economical as the project ages.

Operation Of The Learning Center

A student who chooses to acquire his math through the Mathematics Learning Center does not register for any math courses in September. There won't be any courses to register for.

He trundles down to the MLC when a math mood hits him and discusses his case with the consultant on duty. Different students may want very different things.

He may be a graduate student in experimental medicine who has avoided mathematics all his life only to discover (with horror) that all the papers in his field require math. The consultant will look over the papers, identify the mathematical concepts involved, and suggest a set of MLC packages that will put the doctor in business as soon as possible.

The student may have math needs relevant to another course. This is very common with engineering and science students. The MLC staff would have gone over the course in question with the professor in charge and assembled a list of covering packages.

The student might be someone turned on by problem-solving. The consultant would help him locate packages which challenged his particular motivation.

The student might be marginally interested in math, with not even enough use for it to fill up half a course. He may be involved with art history and have discovered projective geometry and its influence on renaissance art. The consultant would give him the package on renaissance projective geometry, he'd do the same experiments that the ancient painters did and probably be delighted. That might be all the mathematics he'd ever want at university.

The student might be just generally curious—not enough to commit himself to a course—and the consultant could give him a sampling of packages to try on for size.

The possible variations are endless.

The Package

What is this package that the Center hands to each of the students? The package gives a rough description of the math it covers, which should never involve more than a week's worth of work. It lists relevant chapters from several books that the staff has selected, books which are on the shelves. These may include validated instructional material. Unfortunately little of this exists at the moment. The package will also list relevant film clips, displays, or models. It may include supplementary material developed by the Center. It contains a set of covering problems.

The student takes this package, rounds up the books he needs, and sits down to study. When he gets hung-up, he either discusses his problem with another student or with the consultant. The consultant makes a detailed note of each hang-up and files it in a big file for the particular package that caused the trouble, and then straightens out the student and sends him back to study.

When the study is complete the student goes to the secretary and picks up a test which is a sub-set of a master test. If the test indicates competence, the associated fractional credit is put on the student's record and he picks up another package or terminates his study for awhile. If he fails the test, he picks up a deficiency diagnosis and returns to his studying and tries again.

If he really needs a lot of math or is in a strong math mood he can do some heavy studying and in a month earn one or two [illegible] credits. Inside the present structure of [illegible] hours-per-week-final-exam-in-May this kind of naturally paced learning is impossible.

Physical Layout

The MLC is located with its own permanent floor space. There won't be any blackboards on the walls, only bookshelves. There will be some booths to show short dynamic film clips. A lot of mathematical concepts require a dynamic display to be understood and 95 per cent of our students do not have the neural machinery to create dynamic displays in their heads. Most of the needed film clips can be photographed from a computer display screen.

There may be other minor display facilities like simple 3-D still projectors. It would be convenient to have some solid mathematical models that the student can handle—like a special cube from which he can demonstrate to himself that the rotations of a cube form a group which is non-commutative. Some concepts which cause terrible trouble when we attempt to display them on a blackboard are grasped readily in the presence of a model.

Some small programmable desk computers might be useful but a definite need for them would have to be established before they were bought.

The basic floor space of the Center would contain tables like in a pub, with a flow plan that allows easy circulation so that students are encouraged to get up and talk to one another. The subject package which any student is studying should be identifiable visually—perhaps by an overhang device—so that the student at the Center can, without having to ask, be aware of the material on which every other student is working. This will facilitate students who wish to discuss some math hang-ups with other students who are into the same thing.

In another area of the room you will have the consultant's base with the resources he needs.

The Consultant

The consultants will be recruited from among the graduate and honors math students and be paid. They will not act as teachers—the students will teach themselves—the consultants will be used to give advice, deblock problems, correct tests, detect operational flaws.

Their behaviours will be well specified by the Center staff. Each new consultant will be trained by a staff member or an experienced consultant.

He will talk to a new student and make an accurate assessment of the area of math which can be most profitably tackled in terms of the packages that the Center has to offer. If no package exists to fill this need, it will be the duty of the consultant to assign the student to the design team while new packages are made up.

The consultant will tutor but only after a student has been unable to understand the materials provided by the package and has be unable to get another student to explain away the hang-up. Several minutes per question is usually all the time that is required for this type of tutoring.

The consultant will get great training for his Ph.D orals this way. He will never know what question the student will ask or from which part of mathematics it will come. And so he will have to learn how to articulate answers which will satisfy a confused mind.

The consultant will make a formal report on each hang-up he handles, a coherent statement of the problem which will satisfy the members of the design team in charge of software revision.

The consultant will process whichever parts of the tests have to be hand-corrected, and make up a deficiency diagnosis for the failures.

Credit

The present university game is to accumulate credits. This is because our managerial structures attach all the rewards to the credits rather than to the knowledge. Eventually this system has to change. However, at the moment, it would be a strategic mistake to abolish the credit system.

The students' motivational structures are conditioned to respond to credits. If knowledge doesn't have credit sauce on it, the vast majority of them won't eat it. Therefore the students will have to be weaned away from dependence upon credits before a non-credit system will "take."

Administrative problems require knowledge measures. The credit system is the best we have and cannot be discarded without administrative disasters until a better knowledge measure is created.

In spite of this, the credit system can be modified to eliminate its worst consequences. The MLC utilizes such a modified system.

Credits can now be accumulated only in January and May. Why? To be most effective they should be given out as soon as they are earned. You can triple student productivity by making that simple innovation.

The smallest credit given at McGill is half a unit. One unit is normal. Imagine trying to buy a five cent cigar or a seventy-six cent tie in a society where the smallest change is a fifty cent piece. The MLC gives out fractional credits. Each coherent mathematical unit will have credit attached to it roughly proportional to its value and learning effort at a "price" comparable to the present system. For example, a student might earn 0.06 credits for learning how to sketch the derivative of a graphically represented function.

One of the great drawbacks of the credit system is that credit is given for marginal effort. In Math 224 a student can get one credit for a 55% mark on the final exam. This system actually creates students with marginal minds. If you get paid off for sloppy-think you learn sloppy-think.

So the MLC will set competence standards for each of its math packages. No credit will be given for anything less than competence. You get a first class or zero on your test and you can take the test over until you pass. Naturally each package will have associated with it many different tests of the same abilities.

No records will be kept of failures so the constant examining will produce no anxiety.

Students who are used to bell-curve courses—the bell curve distribution of marks means that the teaching was random—tend to be terrified of learning where a first class is the passing mark, but soon become enthusiastic, even amazed, when they find that they are quite capable of first-class work.

The Center keeps a file on each student, listing the credits he has earned and the package for which it has been earned. No credit is given for a package duplicated in a Math Department course passed by the student.

These credits are eventually submitted to the central files. The fractional credit system would, of course, force an overhaul of the long obsolete transcript filing format.

Testing

When a student feels he has mastered the package content he asks the secretary for a test. As I have said, we are testing for competen-

Donald Kingsbury, mathematics professor, proposes a revolutionary learning center where information is attractive, accessible, and relevant.

ce—not grading students by gravel size—and so the test is a first class or nothing affair.

Test refinement has to be continuous and will be the responsibility of the design team. The dangers in a test are: (1) overtesting—asking the student to know things which weren't taught, (2) understanding—asking the student less than we really want.

All test failures are returned to the student in a diagnostic format which pinpoints his deficiencies.

Three testing methods are possible—an individual test may use all three or only one:

1. Oral: the consultant asks questions and evaluates the answers.

2. Written: the consultant corrects the test from a master answer sheet.

3. IBM: many—not all—math concepts can be tested by computer.

Eventually the MLC should have a computer terminal for its testing service. The student enters his answers. The computer recalls the program associated with that test, does an analysis of the student's work to see which abilities correspond to the rightly answered question and which abilities correspond to the wrongly answered question and then prints out for the student: either (1) test passed, or (2) a list of the concepts which the student has not mastered.

The Design Team

In back of all this apparatus, we have our design team of professional mathematicians and learning materials engineers. They are responsible for making up the package content, and the tests, for making decisions about which mathematics is relevant and which isn't, and what is the best available treatment of a given subject. One of their main functions will be the designing of the new learning software.

Mathematics texts are incredibly badly written from a learning point of view though they are much better than the average mathematics lecture. It will not be possible for the MLC to correct this situation immediately. You start from where you are. So the Center will first depend upon the kind of books which are available from the publishers. The packages will direct the students to study from the appropriate sections of these books.

However, the MLC will immediately set up design procedures so that materials which are learner oriented will always be in the process of development. I mentioned before that when a student gets hung-up he has available to him the help of a consultant, and that the consultant makes a specific note of the hang-up and files it. Other material, like student scrap work, may also be collected and filed.

The design team will pick one package to work on at a time. With the aid of the hang-up notes and using Gilbertian methods of organizing content into learnable formats, a new package will be designed and introduced. The automatic revision of this material will continue until it is flaw-free.

As the packages become more effective instruments the workload on the consultants will decrease, allowing a gradual lowering of the staff to student ratio. Thus the Center will become more efficient economically as the quality of its teaching increases. A rough measure of its effectiveness will be credits granted per dollar spent, a readily measurable quantity.

A by-product of the design team will be a set of learner oriented math textbooks so superior to what is now on the market that they will make a significant dent in the multi-million dollar math textbook market. As an incentive to the design staff I propose that they should share in any royalties which might come from publication of the packages.

The Pilot Project

The learning system which I have outlined here will work because it is an assembly of components which have been tested out thoroughly in many different contexts. However, it is not possible to implement such a service for 6,000 students in one year. Detailed procedures have to be worked out and learned by the staff: (1) a strategy for organizing the subject matter, (2) an information retrieval system, (3) methods for identifying and correcting deficiencies, (4) instructional objectives and criterion instruments, (5) training procedures for staff, (6) systems compatability with the ongoing university, (7) Etc.

The first year the MLC should service no more than 100 students. Enrollment would increase as the problems give way to smoothly functioning solutions. Perhaps 400 students could be handled the second year, perhaps 1,000 the third year.

Administration

The administrative apparatus of the Mathematics Learning Center should be independent of the present Mathematics Department. There are several reasons for this. Mathematics at McGill is at present a knowledge monopoly. If that monopoly had demonstrated its ability to meet consumer needs, if it had shown an ability to innovate, to keep abreast of the Twentieth Century, then I could see the MLC operating within its management structures. But the fact is that it has operated like monopolies always act—it has given McGill's math students Russian shoes to wear. The MLC couldn't survive inside the Mathematics Department. The whole mental set of their management procedures would destroy it. However, joint appointments between the MLC and the Math Department should be allowed and the MLC should give priority to hiring Math Department graduate and honors students as consultants.

Nothing could be better for the health of the Mathematics Department than to have it operate in competition with the MLC.

During at least the development phase the director of the MLC should know both mathematics and learning systems. He should be given a crack administrative assistant (not necessarily a mathematician) to relieve him of the details managers are better equipped to handle.

The first four years should see the MLC under the tutelage of the Center For Learning and Development, the director of which should have a veto over all of its actions, including hiring and firing and budget. Every educational experiment should have a father until it grows up.

Central Administration Policy

The concept of a learning system I have developed here presents the university with several difficult problems.

1. How do you superimpose on the present credit system a special credit system where partial credits are recorded at the time they are earned and can be accumulated as fast as the student cares to master the material? However, if the banks can accept deposits in cent units every workday of the year, while keeping tens of thousands of accounts straight, I don't think the management problems involved in the proposed credit system are too much for McGill to cope with.

2. What do you say in course catalogues when their are no courses, only information packages? How do you handle a Center that requires no time table decisions? How do you assemble degrees out of packages rather than out of courses?

3. How do you sell to the university at large the idea of a consumer market in information? When the MLC is established a student will be able to get mathematical credit from either the MLC or the Mathematics Department. Why do I have the feeling that the majority of our professors would react to a free information market about like a Moscow bureaucrat would react to capitalism?

Back In The Kingdom

There we are. Learning systems engineering, which I have imported from the Southern Empire, gives compelling reasons for introducing the MLC. Civilized management practice tells us that the MLC will present no management difficulties.

But how will my brothers accept the idea of a peasant who stands tall and no longer looks like an ox? I don't know. I'm curious to find out. Right now I'm relaxing by the fire, unarmed, admiring the tapestries.

Mr. Kingsbury is a lecturer in the Department of Mathematics, McGill.

References:

Gilbert, T., The Technology of Education, *The Journal of Mathematics*, Jan. 1962.

Kaplan, J., An Example of Student Generated Sequences In Mathematics Instruction, *The Mathematics Teacher*, May 1964.

Kingsbury, D., An Experiment In Higher Education. *Contemporary Educational Psychology*, (R. Jones, ed.), NY, Harper and Row, 1967.

Gagne, R., *The Conditions of Learning*, NY, Holt, Rinehart, Winston, 1965.

Bloom, B., Learning for Mastery, Evaluation Comment, Center for the Study of Evaluation of Instructional Programs, May 1968.

Brethower, D., Instructional Design: A Practicum. Privately printed at the University of Michigan, Ann Arbor, 1968.

Rummler, G., Managing the Instructional Programming Effort, Ann Arbor, University of Michigan 1967.

APPENDIX TWO

SOLVING FOR COST CONSTRAINTS

We make two assumptions:

(1) All functions are continuous. In reality continuous adjustment of some variables may be impossible or meaningless. We discuss these cases following the exposition of the general technique.

(2) The financing criteria is stated in terms of unit cost per student ($\underline{CU}$).
We state the elements which define the value of $\underline{CU}$:

$$\underline{CU} = f(Pe,e,z,x,SA)\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

From the formulae developed in Table I, we know:
$\underline{CU} = C / e$; $\underline{C} = Pt.SA$; $\underline{Pt} = Ta/x$; $\underline{Ta} = Pe.g$; $\underline{g} = e/z$

We define the problem in terms of comparative statistics:
(1) By how much must any variable change to yield a desired $\underline{CU}$ (Cu_d)?
(2) When any of the variables in statement (1) changes, what is the new value of $\underline{CU}$ (Cu_n)?

Arithmetically, from statement (1) there are independent variables ($v_{i,j}$) where i,j = 1....5: where

$$dv_j = 0 \quad \forall v_j \quad j \neq i$$

$$\text{then,} \quad dCU = \frac{\partial f}{\partial v_i} dv_i \quad \ldots\ldots\ldots \quad (3)$$

This equation describes the change in CU for a change in any one variable. It may also be stated to yield the change in any variable as a result of a change in CU.

The exception to the application of this technique is with respect to variable "e". The problem with variable "e" is that any change in enrolment that changes the number of groups (g) proportionately, changes total cost proportionately to enrolment, leaving CU unaffected. We illustrate the argument arithmetically:

From statement (2) above where CU = C/e ... etc,

$$\Delta CU \propto \frac{1}{\Delta e}, \quad \dot{C},$$

Given $\dot{Pe}$, $\dot{x}$, $\dot{SA}$, and $\dot{z}$

For any Δe,

$$\Delta g \propto \Delta e/z$$
$$\therefore \Delta Ta \propto Pe.\Delta g$$
$$\therefore \Delta Pt \propto \Delta Ta/x$$
$$\therefore \Delta C \propto \Delta Pt.SA$$
$$\therefore \Delta C \propto \Delta e$$

i.e. C cannot remain constant
To satisfy $\dot{C}$, with $\dot{Pe}$, $\dot{x}$, $\dot{SA}$, requires $\dot{g}$,

$$\therefore \Delta z \propto \Delta e$$

With reference to the Cost Constraint Table (page 403) line 1 is the starting point of the exercise, with the present CU (notation "p"in the CU column) at $7.94. Its corresponding input information is listed in columns 6, 7, 8, 15 and 16. The resulting outputs are listed in columns 10, 12, 17 and 18.

Assume that policy is to cut CU in half, i.e. CU_d = $3.97. We note this intention on line 2 in the CU column. We apply formula (3) for each variable input except e. As one input variable changes, all others remain in their original state. The way to interpret line 2 is as follows:

2/6: students attend 13 rather than 26 hours per annum cet. par.
2/8: increase class size from 315 to 630 per session, cet. par.
2/15: change the workload from 104 to 208 contact hours, cet. par.
2/16: change the professor's salary from $10,000 to $5,000 cet. par.
To change CU from $7.94 to $3.97 by changing e,

APPLY $CU = \frac{\dot{c}}{e_n}$, where e_n = new $\underline{e}$,
YIELDING $e_n = 1260$

SINCE $z \propto e$, $e_n = 2e$
AND $z = 315$
$z_n = 630$

On line 3 of the Cost Constraint Table we illustrate the new values of e and z to bring CU from $7.94 to $3.97.

Section II of the Cost Constraint Table indicates the effects on output variables for a change in each input variable.

The outputs are listed on the row and occupy columns 10, 12, 17 and 18. The inputs are listed down the input/output column and are the same as those listed in Section I of the Table.

Generally, to read the effect on output variables of a change in any one input variable , locate the relevant input variable in the input/output column, and read the changes in outputs across that line. The values are calculated from manipulation of the formulae in statement 2.

For example, to read the effect on output variables of the salary change described in box 2/16, read line 2, columns 10, 12, 17 and 18. Nothing changes except total cost (box 2/18) which reduces from $5000 to $2500.

The change in e maintains the status quo ante of the values g, Ta, Pt and C.

Line 7, Section I, illustrates an application of problem (2) (what $\underline{CU}_n$ results from an exogenous change of an input variable?) Annual salary changes from $10,000 to $12,000 (see box 7/16). Line 7, column CU indicates that $\underline{CU}_n$ has changed from $7.94 (of line 1) to $9.52. All other inputs are the same as those in line 1.

The effect on output variables (line 7, Section II) is to change C from $5000 to $6000.

Assume that policy makers now wish to bring CU back to $7.94. We note this desire on line 8 in the CU column. We determine what changes in input variables, other than salary, will accomplish this result.

The information appears in Section I, line 8:

8/6 : Cut student participation per annum from 26 to 22 (rounded) hours.

8/7 : Increase enrolment to 756 and,

8/8 : Increase group size to 378.

8/15 : Increase teacher's workload to 125 hours.

The reader should notice that a change in group size without a change in enrolment would be immaterial unless the number of groups needed to handle all the students changed from 2 to 1. But this amount of change would reduce CU way below CU_d. In general, the number of groups is an important discontinuity, and it makes more difference to CU, the fewer the groups to begin with. (For example, changing group requirements from 20 to 18 only reduces Ta by 10%; while changing them from 2 to 1 reduces Ta by 50%).

To read the effect of our changes in Pe, e, z and x on the output variables, consult Section II, lines 8, 9, 10, and 11:

Line 8 : The change in x reduces Pt from .5 to .417, and C from \$6000 to \$5000.

Line 9 and 10 : Although CU becomes CU_d , all output variables remain unchanged.

Line 11 : The change in Pe changes:
Ta from 52 to 43.4
Pt from .5 to .417
C from \$6000 to \$5000.

The reader may be aware that all the changes we have been discussing relate to unit cost per student within each activity. It is possible that this focus on the problem is too microscopic for some purposes. It may be that total cost over a range of activities is more important to policy makers.

In this case, attention would focus on column 18 of the Constraint Table, Section II. The existence of activities then becomes a variable, as well as anything which may change within them. Consideration of such aggregative issues involves tabulating the constraint table, activity by activity, deriving aggregative teaching hour requirements by summing similar categories of Ta, deriving personnel requirements over the whole range of activities by consideration of aggregate "x", and deriving total costs by summing C for each activity. Changes in the total budget for a range of activities may be wrought by policies which involve not only alteration of the activity mix, but also the input structure of any given activity mix.

In fact, that is the general way in which problem solving with this technique should be envisaged, because when we bring the results of the arithmetic in touch with reality, we observe that outputs are often expressed in meaningless units.

For example, we do not hire .417 teachers. We hire 1 teacher. We assume that the remaining .583 of his time is occupied in other activities. If it is not, this discontinuity forces us to cost the activity on the basis of his whole salary, rather than .417 of it.

In practice, the expression of the teaching load (__Ta__) may not be variable in units as fine as one hour. It may be that the way in which teaching commitments are parcelled out in the department, teaching loads change according to rather large and discrete intervals. For example, if teaching loads are portioned according to "the number of courses per person", or the "equivalent course credits per person" rules, then it makes large differences in total contact hours when a load is altered from, say, courses of 6 credit equivalents per man to courses of 8 credit equivalents per man.

Changing the length of contact hours or the number of contact hours, or the frequency of meetings for any activity may or may not matter to the distribution of teaching loads and hence departmental staff requirements. It is necessary to determine the realism of arithmetic results from this technique with the pedagogic and structural realities of departmental functioning.

Nevertheless, the results of the arithmetic are interesting in the sense that they may point to the direction in which changes of policy may be effected to meet some objective. For example, if the exercise is carried out between universities, we may discover that unit cost of activity "_i_" can be cut substantially be eliminating the activity from one university and concentrating it in another. The Constraint Table would show us the quantitative effects of such a change on our input and output variables, while the final decision would probably depend on these numbers as well as the pedagogic implications of the move. The applications are numerous.

FIGURE VI

COST CONSTRAINT TABLE

Line	CU		6 Pe	7 e	8 z	15 x	16 SA
1							
2	p	7.94	26	630	315	104	10 000
3	d	3.97	13	-	630	208	5000
4				1260	630		
5							
6							
7							
8	n	9.52	k	k	k	k	12000
9	d	7.94	21.67	756	378	125	12 000
10							
11							

output / input	10 g	12 Ta	17 Pt	18 C
	2	52	.5	5000
SA	k	k	k	2500
x	k	k	.250	2500
z	1	26	.250	2500
e	1	26	.250	2500
Pe	k	26	.250	2500
SA	k	k	k	6000
x	k	k	.417	5000
z	k	k	k	k
e	k	k	k	k
Pe	k	43.4	.417	5000

Present: CU : p
CU_d : d
CU_n : n
CONSTANT : k
OMIT : -

Cost Constraint Formulae

"v"	To reach a CU_d by changing "v" the new value of "v" is found by	If "v" changes, the value of CU_n is found by: (vn = new "v")
	FORMULAE	
SA	$SA = \frac{CU_d \cdot e}{P_t}$	$CU_n = \frac{P_t \cdot SA_n}{e}$
x	$x = \frac{SA \cdot T_a}{CU_d \cdot e}$	$CU_n = \frac{T_a \cdot SA}{x_n \cdot e}$
z	$z = \frac{P_e \cdot SA}{CU_d \cdot x}$	$CU_n = \frac{P_e \cdot SA}{z_n \cdot x}$
e	$\begin{cases} e = \frac{\dot{c}}{CU_d} \\ z = \frac{e}{\dot{g}} \end{cases}$	$CU_n = \frac{\dot{c}}{e_n}, \quad z_m \propto e_n$
P_e	$P_e = \frac{CU_d \cdot e \cdot x}{g \cdot SA}$	$CU_n = \frac{P_{e_n} \cdot g \cdot SA}{e \cdot x}$

APPENDIX III

The purpose of this appendix is to discuss the application of an extended time horizon to the accounting framework.

Over time, the following variables in the system may change:

(1) Program structures—the number of FIUs available and required within a program,

(2) FIU structures—the number, type and duration of activities within the FIU, and their associated staff commitments,

(3) FIU enrolments,

(4) Faculty workloads—the distribution of contact hour workloads over the various available staff members,

(5) Faculty salaries.

A program budget should predict costs at least over the average amount of time (tu) that an entering student would require to obtain a degree in the specified program. The cost per student for the program is:

$$\sum_{fiu_1}^{x} CU_{t \ldots\ldots tu}$$

where $FIU_{1......x}$ signifies the FIUs the student takes in each year of his program. Since any CU is a function of the above variables, we must predict how they will influence CU over the planning period.

We discuss the factors that influence the variables and the resulting direction of changes they imply for CU.

(1) Program Structures:

Program structures are matters of academic policy. The usual things which influence academic policy may be staff availability, student preferences, and prevailing notions about the academic requirements of the discipline. The program structure may change when any of these factors change. We briefly relate how they may have changed over the long run, and the difference this could make to CU.

With no data gathered to support the contention, it is our intuition that at least over the past half-century, not only have completely new disciplines been created, but existing ones have proliferated into many specialities. Therefore, options with which to construct programs have increased. If the number of courses from which to choose increases more than proportionately to their enrolment, ceteris paribus, unit cost per student increases. A mitigating factor may be that as disciplines are born and expand, more is required of students and they enroll in more courses than they would have before. Obviously this has some indefinite upper limit, depending upon the capacity of the student to study courses.

A more recent concern among a growing number of educators is that the rapid development of specialization has created the side-effect of forming students who insufficiently understand the linkages between their own specialty and those of others. Many students and faculty members now seek to establish the connecting links. Several approaches are common. Firstly, new courses are created which consist of "hors d'oeuvres" from various disciplines thought to be relevant to the student's specialty. Existing staff from the supplementary disciplines contribute sections to the course(s).

Secondly the university may establish an "inter-discipline." Examples of inter-disciplines are Black Studies or Metropolitan Planning. Rather than studying matters relevant to Black experience or metropolitan planning in isolated sections of courses offered by history, economics, sociology and science departments, the new discipline links the various aspects of the subject into a coherent unit. Such programs are staffed by specialists in particular areas, or they may also be staffed by individuals of inter-disciplinary talent who focus the studies on particular problems from several dimensions at once.

Cost differences between these approaches may be substantial. In the former approach, the number of students may be obliged to take the additional course, for which no new staff is hired—rather existing workloads increase by the amount of the added responsibility to teach the "hors d'oeuvres". Ceteris paribus, this solution is bound to be cheaper than the development of a new program, with additional staff, and perhaps limited enrolments for an initial period of some years.

Anyone interested in cost-prediction should be aware of likely trends in program design so that resulting changes in total commitments, enrolments and resource utilization may be assessed. A program budget which takes these factors into account should weigh marginal costs with marginal benefits to the extent that they can be accounted with some conviction.

(2) FIU Structures:

These may change over time because teaching techniques change. There are variants that go from large classes with automated instruction to small classes with individual instruction. Dr. Malott's project is systematized instruction with large classes, small groups and substantial student input. We have seen that the choice of technique may make large differences to unit costs. Trends in teaching techniques are essential inputs to cost prediction.

(3) Course Enrolments:

Course enrolments may depend upon the following factors:

(a) the number of students entering the programs,

(b) the program structure: the higher the ratio of students-to-options, the greater may be the enrolment in any particular course,

(c) the transition ratio from one course in a sequence to another, the value of which would depend upon:

- (i) the pass rate: the more who pass FIU_1, the greater the enrolment in FIU_2. This factor depends upon student ability relative to standards, quality of pedagogy, drop-out rates, et. al.
- (ii) the repeat rate: of those who fail FIU_1, the more who repeat it, the higher its enrolment is likely to be.
- (iii) the drop-out rate etc.

(d) non-sequential course entrants.

(4) Faculty Workload and its Distribution:

This may depend upon:

(a) staff availability: the less staff relative to course options in the department, the heavier the workload may be per staff member,

(b) course structures: the more teacher oriented the pedagogy, the heavier the workload may be,

(c) research and administration commitments: the greater they are the lower the instructional workload may be,

(d) the prevailing notion of the "normal workload",

(e) the availability of teaching assistants.

(5) Faculty Salaries:

Faculty salaries change because:

(a) they are adjusted for age, experience, cost of living, statutory increments, promotion, shifts in overall staff qualification,

(b) market forces may equilibrate supply and demand for certain kinds of staff through the price mechanism.*

A rough method of estimating salaries over a three year period would consist of projecting recent trends in their movement, adjusted for any unusual market conditions that we may anticipate.

Given this list of planning variables—and it may not be exhaustive—projects abound in the literature to forecast enrolments, salary trends, and related matters. We do not explore them here, but make the point that our accounting framework is a taxonomy that may be used for a synthetic exposition of projected values for the variables and for computation of their cost implications.

---

* See J. Bordeleau, A.P. Contandriopoulos, N. Hung, "Etudes et propositions en vue de la mise en place d'une échelle normée de traitement pour les professeurs des universités du Québec" for a study of factors under salaries of university professors.

APPENDIX IV

TABLES

A. DATA PER FIU AND ACTIVITY FOR 22 VARIABLES BY DEPARTMENT

Only the set of Tables for one department is included, to illustrate the nature of the data available. The complete set of Tables and the inventory of professors' workloads by department are available upon request from the Secretariat of the Conference of Rectors and Principals of Quebec Universities.

```
I       I  1  I  2  I  3  I  4 I  5  I   6   I  7 I  8  I  9  I10I  11 I  12 I  13 I  14 I 15I    16    I    17    I  18  I  19 I  20  I  21 I 22
IFIU-I. I (S) I (B) I (D) I(Y)I (H) I (PE)  I(E) I(Z1) I(Z2) I G I(TB) I(TA) I(L)  I(N)  I(X)I  ( SA )  I   (PT)   I (C)  I( CU )I (CH) I (AI)I(TIZ
I       I     I     I     I   I     I       I    I     I     I  I     I     I     I     I   I          I          I      I      I      I     I
I100 L  I23.0 I1.0  I1.0  I  3I 3.0 I  69.0 I1246I  623I     I 2I  6.0I   52I0497 I0002 I 92I12400.00 I     .570 I  7068I  5.67I134.78I  .22I3267
I       I     I     I     I   I     I       I    I     I     I  I     I   28I0487 I0001 I154I16000.00 I     .179 I  2868I  2.30I103.90I  .17I1719
I       I     I     I     I   I     I       I    I     I     I  I     I   25I0496 I0002 I109I12300.00 I     .228 I  2803I  2.25I112.84I  .18I1547
I       I     I     I     I   I     I       I    I     I     I  I     I   40I1001 I0001 I221I17400.00 I     .181 I  3151I  2.53I 78.73I  .13I2493
I    ST I     I     I     I   I     I  69.0 I    I     I     I  I     I  145I     I     I   I          I          I 15889I 12.75I109.66I  .18I
I100 M  I 0.0 I0.0  I0.0  I  0I 0.0 I   0.0 I1246I     I    0I 0I  0.0I  138IDEMO I0000 I  1I    12.82 I  138.000 I  1769I  1.42I 12.82I     I
I       I     I     I     I   I     I       I    I     I    0I 0I  0.0I  138IDEMO I0000 I  1I    12.82 I  138.000 I  1769I  1.42I 12.82I     I
I       I     I     I     I   I     I       I    I     I    0I 0I  0.0I  138IDEMO I0000 I  1I    12.82 I  138.000 I  1769I  1.42I 12.82I     I
I    ST I     I     I     I   I     I   0.0 I    I     I     I  I     I  414I     I     I   I          I          I  5307I  4.26I 12.82I    8I
I100 E  I 0.0 I0.0  I0.0  I  0I 0.0 I   0.0 I1246I     I    0I 0I  0.0I  140ICOOR I0000 I  1I    12.82 I  140.000 I  1795I  1.44I 12.82I     I
I       I     I     I     I   I     I       I    I     I    0I 0I  0.0I  140ICOOH I0000 I  1I    12.82 I  140.000 I  1795I  1.44I 12.82I     I
I    ST I     I     I     I   I     I   0.0 I    I     I     I  I     I  280I     I     I   I          I          I  3590I  2.88I 12.82I    8I
I100 S  I20.0 I1.0  I1.0  I  1I 1.0 I  20.0 I1246I   54I     I23I 23.0I   62I100M IPDHF I 62I 3600.00  I    1.000 I  3600I  2.89I 58.06I 1.08I 334
I       I     I     I     I   I     I       I    I     I     I  I     I   33I0494 I0001 I 60I20500.00 I     .550 I 11275I  9.05I341.67I 6.33I 178
I       I     I     I     I   I     I       I    I     I     I  I     I   22I0490 I0001 I 75I14800.00 I     .293 I  4341I  3.48I197.33I 3.65I 118
I       I     I     I     I   I     I       I    I     I     I  I     I   14I0497 I0002 I 92I12400.00 I     .152 I  1887I  1.51I134.78I 2.50I  75
I       I     I     I     I   I     I       I    I     I     I  I     I   24I1007 I0003 I 93I10500.00 I     .258 I  2710I  2.17I112.90I 2.09I 125
I       I     I     I     I   I     I       I    I     I     I  I     I   27I0494 I0002 I107I14000.00 I     .265 I  3706I  2.97I137.25I 2.54I 145
I       I     I     I     I   I     I       I    I     I     I  I     I   24I0498 I0002 I 77I12400.00 I     .312 I  3865I  3.10I161.04I 2.98I 125
I       I     I     I     I   I     I       I    I     I     I  I     I   31I0495 I0002 I158I13300.00 I     .196 I  2609I  2.09I 84.18I 1.56I 167
I       I     I     I     I   I     I       I    I     I     I  I     I   16I1006 I0003 I 55I10500.00 I     .291 I  3055I  2.45I190.91I 3.54I  86
I       I     I     I     I   I     I       I    I     I     I  I     I    8I0487 I0001 I154I16000.00 I     .052 I   831I   .67I103.90I 1.92I  43
I       I     I     I     I   I     I       I    I     I     I  I     I   31I0509 I0003 I288I11600.00 I     .108 I  1249I  1.00I 40.28I  .75I 167
I       I     I     I     I   I     I       I    I     I     I  I     I   23I1005 I0003 I124I10000.00 I     .185 I  1855I  1.49I 80.65I 1.49I 124
I       I     I     I     I   I     I       I    I     I     I  I     I   26I0503 I0003 I 43I12200.00 I     .605 I  7377I  5.92I283.72I 5.25I 140
I       I     I     I     I   I     I       I    I     I     I  I     I   11I0499 I0002 I109I12300.00 I     .101 I  1241I  1.00I112.84I 2.09I  59
I       I     I     I     I   I     I       I    I     I     I  I     I   18I0491 I0001 I241I12950.00 I     .075 I   967I   .78I 53.73I 1.00I  97
I       I     I     I     I   I     I       I    I     I     I  I     I   14I0501 I0003 I157I11600.00 I     .115 I  1330I  1.07I 73.89I 1.37I  97
I       I     I     I     I   I     I       I    I     I     I  I     I   18I0499 I0003 I327I11900.00 I     .055 I   655I   .53I 36.39I  .67I  97
I       I     I     I     I   I     I       I    I     I     I  I     I   18I0481 I0001 I122I18700.00 I     .148 I  2759I  2.21I153.28I 2.84I  97
I       I     I     I     I   I     I       I    I     I     I  I     I   18I0504 I0001 I303I22000.00 I     .059 I  1307I  1.05I 72.61I 1.34I  97
I       I     I     I     I   I     I       I    I     I     I  I     I    8I1001 I0001 I169I17400.00 I     .047 I   824I   .66I102.96I 1.91I  43
I       I     I     I     I   I     I       I    I     I     I  I     I   14I1013 IPDHF I 14I 3600.00  I    1.000 I  3600I  2.89I257.14I 4.76I  75
I    ST I     I     I     I   I     I  20.0 I    I     I     I  I     I  464I     I     I   I          I          I 61042I 48.99I131.56I 2.45I
I100 A  I22.0 I1.0  I3.0  I  1I 3.0 I  64.0 I1306I     I    4I32I 96.0I 2112IDEMO I0000 I  1I    12.82 I 2112.000 I 27076I 20.73I 12.82I     I
I       I     I     I     I   I     I       I    I     I     I  I     I     I     I     I   I          I          I      I      I      I     I
```

```
+-------+----+---+---+---+-----+------+----+----+----+-+----+----+----+----+----+---------+---------+------+-------+------+------+-----+
I       I    I   I   I   I     I      I    I    I    I I    I    I    I    I    I         I         I      I       I      I      I     I
IFIU-1.I (S)I(B)I(D)I(Y)I (H) I (PE) I(E) I(Z1)I(Z2)I GI(TB)I(TA)I(L) I(N) I(X) I ( SA )  I  (PT)   I (C)  I ( CU )I (CH) I (AI) I(TIZ)I
I       I    I   I   I   I     I      I    I    I    I I    I    I    I    I    I         I         I      I       I      I      I     I
+=======+====+===+===+===+=====+======+====+====+====+=+====+====+====+====+====+=========+=========+======+=======+======+======+=====+
+-------+----+---+---+---+-----+------+----+----+----+-+----+----+----+----+----+---------+---------+------+-------+------+------+-----+
I       I    I   I   I   I     I156.0I    I    I    I I    I13415I   I    I    I         I         I112905I 89.62I 33.06I   .58I     I
I  TOT  I    I   I   I   I     I      I    I    I    I I    I    I    I    I    I         I         I      I       I      I      I     I
+-------+----+---+---+---+-----+------+----+----+----+-+----+----+----+----+----+---------+---------+------+-------+------+------+-----+
I022 L I26.0I1.0I1.0I  2I  3.0I  55.0I 134I 134I    I1I 2.0I  52I049I0001I  24I12450.00I     .216I  2794I  20.85I 53.73I   .40I 6968I
I       I    I   I   I   I     I      I    I    I    I I    I    I    I    I    I         I         I      I       I      I      I     I
+-------+----+---+---+---+-----+------+----+----+----+-+----+----+----+----+----+---------+---------+------+-------+------+------+-----+
I022 S I26.0I1.0I1.0I  1I  1.0I  26.0I 134I  45I    I3I 3.0I  78I049I0001I  24I12950.00I     .324I  4191I  31.28I 53.73I  1.19I 3510I
I       I    I   I   I   I     I      I    I    I    I I    I    I    I    I    I         I         I      I       I      I      I     I
+-------+----+---+---+---+-----+------+----+----+----+-+----+----+----+----+----+---------+---------+------+-------+------+------+-----+
I022 A I26.0I1.0I3.0I  1I  3.0I  78.0I 134I    I    I17I 8I24.0I 624IDEMOI0000I   1I    12.82I  624.000I  8000I  59.70I 12.82I      I     I
I       I    I   I   I   I     I      I    I    I    I I    I    I    I    I    I         I         I      I       I      I      I     I
+-------+----+---+---+---+-----+------+----+----+----+-+----+----+----+----+----+---------+---------+------+-------+------+------+-----+
I       I    I   I   I   I     I      I    I    I    I I    I    I    I    I    I         I         I 14985I 111.83I 19.87I   .72I     I
I  TOT  I    I   I   I   I     I154.0I    I    I    I I    I 754I    I    I    I         I         I      I       I      I      I     I
I       I    I   I   I   I     I      I    I    I    I I    I    I    I    I    I         I         I      I       I      I      I     I
+-------+----+---+---+---+-----+------+----+----+----+-+----+----+----+----+----+---------+---------+------+-------+------+------+-----+
I       I    I   I   I   I     I      I    I    I    I I    I    I    I    I    I         I     .741I  2224I  35.88I 44.78I   .72I 3040I
I130 L I24.0I1.0I1.0I  3I  3.0I  75.0I  62I  62I    I1I 3.0I  50I1004I0001I  67I  3000.00I     .305I  2444I  39.41I121.21I  1.96I 1249I
I       I    I   I   I   I     I      I    I    I    I I    I  20I04A8I0002I  66I  8000.00I         I      I       I      I      I     I
I       I    I   I   I   I     I      I    I    I    I I    I    I    I    I    I         I         I  4668I  75.29I 66.84I  1.05I     I
I    ST I    I   I   I   I     I  72.0I    I    I    I I    I  70I    I    I    I         I         I      I       I      I      I     I
+-------+----+---+---+---+-----+------+----+----+----+-+----+----+----+----+----+---------+---------+------+-------+------+------+-----+
I130 S I24.0I1.0I1.0I  1I  1.0I  74.0I  62I  31I    I2I 2.0I  17I1004I0001I  67I  3000.00I     .251I   752I  12.13I 44.78I  1.44I  520I
I       I    I   I   I   I     I      I    I    I    I I    I   7I04A8I0002I  66I  8000.00I     .109I   873I  14.08I121.21I  3.91I  223I
I       I    I   I   I   I     I      I    I    I    I I    I  24I1011IPD4FI 114I  6600.00I     .211I  1389I  22.41I 57.89I  1.87I  744I
I       I    I   I   I   I     I      I    I    I    I I    I    I    I    I    I         I         I  3014I  48.62I 62.80I  2.03I     I
I    ST I    I   I   I   I     I  24.0I    I    I    I I    I  48I    I    I    I         I         I      I       I      I      I     I
+-------+----+---+---+---+-----+------+----+----+----+-+----+----+----+----+----+---------+---------+------+-------+------+------+-----+
I       I    I   I   I   I     I      I    I    I    I I    I    I    I    I    I         I         I  7683I 123.91I 65.19I  1.29I     I
I  TOT  I    I   I   I   I     I  96.0I    I    I    I I    I 118I    I    I    I         I         I      I       I      I      I     I
I       I    I   I   I   I     I      I    I    I    I I    I    I    I    I    I         I         I      I       I      I      I     I
+-------+----+---+---+---+-----+------+----+----+----+-+----+----+----+----+----+---------+---------+------+-------+------+------+-----+
I202 L I26.0I1.0I1.0I  2I  3.0I  55.0I 513I 513I    I1I 2.0I  52I0499I0003I 327I11900.00I     .159I  1892I   3.69I 36.39I   .07I26676I
I       I    I   I   I   I     I      I    I    I    I I    I    I    I    I    I         I         I      I       I      I      I     I
+-------+----+---+---+---+-----+------+----+----+----+-+----+----+----+----+----+---------+---------+------+-------+------+------+-----+
I202 S I 0.0I0.0I0.0I  0I  0.0I   0.0I 513I 513I    I1I 0.0I 182I0499I0003I 327I11900.00I     .557I  6623I  12.91I 36.39I   .07I93366I
I       I    I   I   I   I     I      I    I    I    I I    I    I    I    I    I         I         I      I       I      I      I     I
+-------+----+---+---+---+-----+------+----+----+----+-+----+----+----+----+----+---------+---------+------+-------+------+------+-----+
I202 A I26.0I1.0I3.0I  1I  3.0I  78.0I 513I    I    I1/130I90.0I2340IDEMOI0000I   1I    12.82I 2340.000I 29999I  58.48I 12.82I      I     I
I       I    I   I   I   I     I      I    I    I    I I    I    I    I    I    I         I         I      I       I      I      I     I
+-------+----+---+---+---+-----+------+----+----+----+-+----+----+----+----+----+---------+---------+------+-------+------+------+-----+
I202 E I 0.0I0.0I0.0I  0I  0.0I   0.0I 513I    I    I0I   0I 0.0I 234ICORRI0003I   1I    12.82I  234.000I  3000I   5.85I 12.82I      I     I
I       I    I   I   I   I     I      I    I    I    I I    I    I    I    I    I         I         I      I       I      I      I     I
+-------+----+---+---+---+-----+------+----+----+----+-+----+----+----+----+----+---------+---------+------+-------+------+------+-----+
I  TOT  I    I   I   I   I     I 138.0I    I    I    I I    I12808I   I    I    I         I         I 41514I  80.92I 14.78I   .62I     I
I       I    I   I   I   I     I      I    I    I    I I    I    I    I    I    I         I         I      I       I      I      I     I
```

IU-I.	(S)	(R)	(D)	(Y)	(H)	(PE)	(E)	(Z1)	(Z2)	G	(TB)	(TA)	(L)	(N)	(X)	(SA)	(PT)	(C)	(CU)	(CH)	(AI)	(TIZ)
203 L	26.0	1.0	1.0	2	2.0	52.0	250	250		1	2.0	46	1007	0003	93	10500.00	.492	5166	20.67	112.90	.45	11439
												6	10485	0001	136	18300.00	.046	840	3.36	134.56	.54	1559
ST						52.0						52						6006	24.02	115.50	.46	
203 S	26.0	1.0	1.0	1	1.0	26.0	250	250		1	1.0	23	1007	0003	93	10500.00	.240	2583	10.33	112.90	.45	5719
												3	10485	0001	136	18300.00	.023	420	1.68	134.56	.54	779
ST						26.0						26						3003	12.01	115.50	.46	
TOT						78.0						78						9009	36.04	115.50	.46	
07 L	26.0	1.0	1.0	1	1.0	26.0	155	78		2	2.0	52	0496	0002	109	12300.00	.477	5868	37.86	112.84	1.45	4056
07 A	26.0	1.0	4.0	1	4.0	104.0	155		14	11	44.0	1144	DEMO	0000	1	12.82	1144.000	14666	94.62	12.82		
TOT						130.0						1196						20534	132.48	17.17	1.02	
52 L	26.0	1.0	1.0	3	3.0	78.0	124	124		1	3.0	78	0504	0001	303	22000.00	.257	5663	45.67	72.61	.59	9672
52 S	26.0	1.0	1.0	1	1.0	26.0	124	62		2	2.0	52	0504	0001	303	22000.00	.172	3776	30.45	72.61	1.17	3224
TOT						104.0						130						9439	76.12	72.61	.73	
63CA	13.0	1.0	3.0	1	3.0	39.0	25	25		1	3.0	39	0486	0002	156	13400.00	.250	3350	134.00	85.90	3.44	975
									25	1	3.0	39	DEMO	0000	1	12.82	39.000	500	20.00	12.82		
ST						39.0						78						3850	154.00	49.36	3.95	
83 L	26.0	1.0	1.0	3	3.0	78.0	79	79		1	3.0	39	1006	0003	55	10500.00	.709	7445	94.25	190.91	2.42	3081
												39	0489	0002	117	10500.00	.333	3500	44.30	89.74	1.14	3081
ST						78.0						78						10945	138.55	140.33	1.78	
92 A	13.0	1.0	3.0	1	3.0	39.0	83		1(	5	75.0	195	DEMO	0000	1	12.82	195.000	2500	30.12	12.82		

FIU-I.	(S)	(B)	(D)	(Y)	(H)	(PE)	(E)	(Z1)	(Z2)	G	(TB)	(TA)	(L)	(N)	(X)	(SA)	(PT)	(C)	(CU)	(CH)	(AI)	(TIZ)
301 L	26.0	1.0	1.0	2	2.0	55.0	153	153		1	2.0	52	0500	0003	288	11600.00	.181	2094	13.69	40.28	.26	7956
301 S	26.0	1.0	1.0	1	1.0	26.0	153	153		1	1.0	26	0500	0003	288	11600.00	.090	1047	6.84	40.28	.26	3978
TOT						78.0						78						3142	20.53	40.28	.26	
302 L	26.0	1.0	1.0	2	2.0	55.0	250	250		1	2.0	52	0481	0001	122	18700.00	.428	7970	31.88	153.28	.61	13000
302 S	26.0	1.0	1.0	1	1.0	26.0	250	250		1	1.0	26	0481	0001	122	18700.00	.213	3985	15.94	153.28	.61	6500
TOT						78.0						78						11956	47.82	153.28	.61	
303 L	26.0	1.0	1.0	2	2.0	55.0	48	48		1	2.0	52	0489	0002	117	14400.00	.444	6400	133.33	123.08	2.56	2496
303 S	26.0	1.0	1.0	1	1.0	26.0	48	48		1	1.0	26	0489	0002	117	14400.00	.222	3200	66.67	123.08	2.56	1248
TOT						78.0						78						9600	200.00	123.08	2.56	
351 C	26.0	1.0	1.0	2	2.0	52.0	25	25		1	2.0	52	0495	0002	158	13300.00	.329	4377	175.09	84.18	3.37	1300
351 A	26.0	1.0	3.0	1	3.0	78.0	25		13	2	6.0	156	DEMO	0000	1	12.82	156.000	2000	80.00	12.82		
TOT						130.0						208						6377	255.09	30.66	1.96	
362 L	13.0	1.0	1.0	3	3.0	39.0	99	99		1	3.0	39	0501	0003	157	11600.00	.248	2882	29.11	73.89	.75	3861
352 S	13.0	1.0	1.0	1	1.0	13.0	99	99		1	1.0	13	0501	0003	157	11600.00	.083	961	9.70	73.89	.75	1287
356 L	26.0	1.0	2.0	1	2.0	52.0	35	35		1	2.0	52	0493	0002	338	13500.00	.154	2077	59.34	39.94	1.14	1820

FIU-I.	(S)	(H)	(O)	(Y)	(H)	(PF)	(E)	(Z1)	(Z2)	G	(TB)	(TA)	(L)	(N)	(X)	(SA)	(PT)	(C)	(CU)	(CH)	(AI)	(TIZ)
356 S	0.0	0.0	0.0	0	0.0	0.0	35		0	0	0.0	78	0493	0002	338	13500.00	.231	3115	89.01	39.94		
TOT						52.0						130						5192	148.35	39.94	2.85	
362 A	13.0	1.0	4.0	1	4.0	52.0	99		25	4	76.0	208	DEMO	0000	1	12.82	208.000	2667	26.93	12.82		
363CA	13.0	1.0	3.0	1	3.0	39.0	56	56		1	3.0	39	0486	0002	56	13400.00	.250	3350	59.82	85.90	1.53	2184
									18	3	9.0	117	DEMO	0000	1	12.82	117.000	1500	26.78	12.82		
ST						39.0						156						4850	86.61	31.09	2.22	
83 L	26.0	1.0	1.0	2	2.0	52.0	22	22		1	2.0	26	0502	0003	65	11300.00	.400	4520	205.45	173.85	7.90	572
												26	0490	0001	75	14800.00	.347	5131	233.21	197.33	8.97	572
ST						52.0						52						9651	438.67	185.59	8.44	
83 S	26.0	1.0	1.0	1	1.0	26.0	22	22		1	1.0	13	0502	0003	65	11300.00	.200	2260	102.73	173.85	7.90	286
												13	0490	0001	75	14800.00	.173	2565	116.61	197.33	8.97	286
ST						24.0						26						4825	219.33	185.59	8.44	
TOT						78.0						78						14476	658.00	185.59	8.44	
37 L	26.0	1.0	1.0	2	2.0	52.0	36	36		1	2.0	52	0487	0001	54	12000.00	.338	5403	150.07	103.90	2.89	1872
7 S	26.0	1.0	1.0	1	1.0	24.0	65	36		2	2.0	52	0487	0001	54	12000.00	.338	5403	83.12	103.90	2.89	1872
7 A	26.0	1.0	3.0	1	3.0	78.0	36		12	3	9.0	234	DEMO	0000	1	12.82	234.000	3000	83.33	12.82		
TOT						154.0						338						13805	316.52	40.84	2.03	
L	13.0	1.0	1.0	3	3.0	39.0	13	13		1	3.0	39	0485	0001	36	18300.00	.287	5248	403.68	134.56	10.35	507

```
I        I     I    I    I   I     I      I    I    I    I  I     I    I    I    I    I          I        I     I       I       I      I     I
IFIU-I. I (S) I(B) I(D) I(Y)I (H) I (PF) I(E) I(Z1)I(Z2)I GI(TB)I(TA)I(L) I(N) I(X) I ( SA )   I  (PT)  I (C) I ( CU )I (CH)  I (AI) I(TIZ)I
I        I     I    I    I   I     I      I    I    I    I  I     I    I    I    I    I          I        I     I       I       I      I     I
I404 S  I13.0I1.0I1.0I  1I  1.0I  13.0I  13I  13I    I 1I  1.0I  13I0485I0001I 134I18300.00I    .096I 1749I 134.56I134.56I 10.35I  169I
I TOT   I     I    I    I   I     I  59.0I    I    I    I  I     I  52I    I    I    I          I        I 6997I 538.24I134.56I 10.35I     I
I450CL  I13.0I1.0I1.0I  1I  1.0I  13.0I   8I   8I    I 1I  1.0I  13I0488I0002I  66I 8000.00I    .197I 1576I 196.97I121.21I 15.15I  104I
I450CS  I13.0I1.0I1.0I  1I  1.0I  13.0I   8I   8I    I 1I  1.0I  13I0488I0002I  66I 8000.00I    .197I 1576I 196.97I121.21I 15.15I  104I
I TOT   I     I    I    I   I     I  26.0I    I    I    I  I     I  26I    I    I    I          I        I 3152I 393.94I121.21I 15.15I     I
I451 L  I13.0I1.0I1.0I  2I  2.0I  26.0I  13I  13I    I 1I  2.0I  26I0500I0003I 288I11600.00I    .090I 1047I  80.56I 40.28I  3.10I  338I
I452 L  I13.0I1.0I1.0I  2I  2.0I  26.0I  26I  26I    I 1I  2.0I  13I1001I0001I 221I17400.00I    .059I 1024I  39.37I 78.73I  3.03I  338I
I        I     I    I    I   I     I      I    I    I    I  I     I  13I0503I0003I  43I12200.00I    .302I 3688I 141.86I283.72I 10.91I  338I
I   ST  I     I    I    I   I     I  26.0I    I    I    I  I     I  26I    I    I    I          I        I 4712I 181.23I181.23I  6.97I     I
I453 L  I13.0I1.0I1.0I  2I  2.0I  26.0I  62I  62I    I 1I  2.0I  26I0497I0002I  92I12400.00I    .284I 3504I  56.52I134.78I  2.17I 1612I
I455 L  I13.0I1.0I1.0I  2I  2.0I  26.0I  40I  40I    I 1I  2.0I  26I0484I0001I  60I26500.00I    .433I 8883I 222.08I341.67I  8.54I 1040I
I456 L  I13.0I1.0I1.0I  2I  2.0I  26.0I   5I   5I    I 1I  2.0I  26I0493I0002I 338I13500.00I    .077I 1038I 207.69I 39.94I  7.99I  130I
I456 S  I13.0I1.0I1.0I  1I  1.0I  13.0I   5I   5I    I 1I  1.0I  13I0493I0002I 338I13500.00I    .038I  519I 103.85I 39.94I  7.99I   65I
I TOT   I     I    I    I   I     I  39.0I    I    I    I  I     I  39I    I    I    I          I        I 1558I 311.54I 39.94I  7.99I     I
I457 L  I13.0I1.0I1.0I  1I  1.0I  13.0I  38I  38I    I 1I  1.0I  13I0487I0001I 154I19000.00I    .084I 1351I  35.54I103.90I  2.73I  494I
I457 A  I13.0I1.0I3.0I  1I  3.0I  39.0I  38I    I   *I10I 30.0I 390IDEMOI0000I   1I    12.82I 390.000I 5000I 131.57I 12.82I      I     I
```

FIU-I.	(S)	(H)	(D)	(Y)	(H)	(PE)	(E)	(Z1)	(Z2)	G	(TB)	(TA)	(L)	(N)	(X)	(SA)	(PT)	(C)	(CU)	(CH)	(AI)	(TIZ)
TOT						52.0						403						6350	167.12	15.76	3.21	
457BL	12.0	1.0	1.0	1	1.0	12.0	33	33		1	1.0	7	0487	0001	154	19000.00	.045	727	22.04	103.90	3.15	231
												3	0496	0002	109	12300.00	.028	339	10.26	112.84	3.42	99
												1	0484	0001	60	20500.00	.017	342	10.35	341.67	10.35	33
												1	0490	0001	75	14800.00	.013	197	5.98	197.33	5.98	33
ST						12.0						12						1605	48.63	133.73	4.05	
457RA	13.0	1.0	3.0	1	3.0	39.0	33		4	8	24.0	312	DEMO	0000	1	12.82	312.000	4000	121.21	12.82		
TOT						51.0						324						5605	169.84	17.30	3.33	
458 L	13.0	1.0	1.0	2	2.0	26.0	55	55		1	2.0	26	0482	0001	114	22000.00	.228	5018	91.23	192.98	3.51	1430
459 L	13.0	1.0	1.0	1	1.0	13.0	11	11		1	1.0	13	0488	0002	66	8000.00	.197	1576	143.25	121.21	11.02	143
463 A	13.0	1.0	6.0	1	6.0	78.0	10	10		1	6.0	78	0486	0002	156	13400.00	.500	6700	670.00	85.90	8.59	780
									10	1	6.0	78	DEMO	0000	1	12.82	78.000	1000	100.00	12.82		
ST						78.0						156						7700	770.00	49.36	9.87	
473 L	13.0	1.0	1.0	2	2.0	26.0	38	38		1	2.0	26	1003	0001	26	1000.00	1.000	1000	26.32	38.46	1.01	988
82 L	13.0	1.0	1.0	2	2.0	26.0	27	27		1	2.0	18	0491	0001	241	12950.00	.074	964	35.70	53.73	1.99	484
												8	0501	0003	157	11600.00	.051	596	22.06	73.89	2.74	217
ST						26.0						26						1560	57.76	59.98	2.22	
86 L	13.0	1.0	1.0	2	2.0	26.0	5	5		1	2.0	26	0493	0002	338	13500.00	.077	1038	207.69	39.94	7.99	130
83 L	13.0	1.0	1.0	2	2.0	26.0	6	6		1	2.0	26	0498	0002	77	12400.00	.338	4187	697.84	161.04	26.84	156
87 L	13.0	1.0	1.0	2	2.0	26.0	9	9		1	2.0	13	0496	0002	109	12300.00	.119	1467	163.00	112.84	12.54	117
												13	0487	0001	154	16000.00	.084	1351	150.07	103.90	11.54	117

```
IU-I.I (S)I(B)I(D)I(Y)I (H) I (PF) I(E) I(Z1)I(Z2)I GI(TB)I(TA)I(L) I(N) I(X) I ( SA ) I (PT)  I (C)  I ( CU )I (CH)  I (AI)  I(TIZ)I
=========================================================================================================================
                                                                                     I  2818I  313.07I108.37I  12.04I
I ST I    I    I    I   I      I  24.0I    I    I    I  I      I 26I    I     I    I
                                                                      .684I  4516I1128.95I 57.89I  14.47I  312I
492 A I13.0I1.0I6.0I  1I  6.0I  78.0I  4I  4I    I 1I  6.0I  TdI101I SLASI 114I 6600.00I
                                                                      .045I   727I 242.42I103.90I  34.63I   21I
                                                                      .046I   564I 188.07I112.84I  37.61I   15I
497 L I13.0I1.0I1.0I  1I  1.0I  13.0I  3I  3I    I 1I  1.0I   7I0487I0001I 154I19000.00I
                                                                      .013I   161I  53.68I161.04I  53.68I    3I
                                                        5I0496I0002I 109I12300.00I
                                                        1I0498I0002I  77I12400.00I
                                                                            I  1453I 484.18I111.73I  37.24I
                                                   I 13I    I     I    I
  ST I    I    I    I   I      I  13.0I    I    I    I  I      I
                                                                    39.000I   500I 166.66I 12.82I
497 A I13.0I1.0I3.0I  1I  3.0I  39.0I  3I    I   3I 1I  3.0I  39IDEMOI0000I   1I   12.82I
                                                                            I  1953I 650.84I 37.55I  12.52I
                                                   I 52I    I     I    I
I TOT I    I    I    I   I      I  52.0I    I    I    I  I      I
                                                                      .038I   519I 129.81I 39.94I   9.99I   52I
1496 L I13.0I1.0I1.0I  1I  1.0I  13.0I  4I  4I    I 1I  1.0I  13I0493I0002I 338I13500.00I
                                                                      .077I  1038I 259.62I 39.94I  39.94I   26I
1496 D I13.0I1.0I .5I  1I   .5I   6.5I  4I  1I    I 4I  2.0I  26I0493I0002I 338I13500.00I
                                                                            I  1558I 389.42I 39.94I  19.97I
                                                   I 39I    I     I    I
I TOT I    I    I    I   I      I  19.5I    I    I    I  I      I
                                                                      .231I  3115I1557.69I 39.94I  39.94I   78I
1600 D I26.0I1.0I1.5I  1I  1.5I  39.0I  2I  1I    I 2I  3.0I  78I0493I0002I 338I13500.00I
                                                                      .181I  2094I  87.27I 40.28I   1.68I 1248I
1601 L I26.0I1.0I1.0I  2I  2.0I  52.0I 24I 24I    I 1I  2.0I  52I0500I0003I 288I11600.00I
                                                                      .090I  1047I  43.63I 40.28I   1.68I  624I
1601 S I26.0I1.0I1.0I  1I  1.0I  26.0I 24I 24I    I 1I  1.0I  26I0500I0003I 288I11600.00I
                                                                            I  3142I 130.90I 40.28I   1.68I
                                                   I 78I    I     I    I
I TOT I    I    I    I   I      I  78.0I    I    I    I  I      I
                                                                      .338I  4187I 174.46I161.04I   6.71I  624I
1602 L I13.0I1.0I1.0I  2I  2.0I  26.0I 24I 24I    I 1I  2.0I  26I0498I0001I  77I12400.00I
                                                                      .235I  4094I 409.41I 78.73I   7.87I  520I
1621 L I26.0I1.0I1.0I  2I  2.0I  52.0I 10I 10I    I 1I  2.0I  52I1001I0001I 221I11400.00I
```

FIU-I.	(S)	(A)	(D)	(Y)	(H)	(PE)	(E)	(Z1)	(Z2)	G	(TB)	(TA)	(L)	(N)	(X)	(SA)	(PT)	(C)	(CU)	(CM)	(AI)	(TIZ)
1622 L	13.0	1.0	1.0	2	2.0	24.0	16	16		1	2.0	26	0481	0001	122	18700.00	.213	3985	249.08	153.28	9.58	416
1623 L	17.0	1.0	1.0	1	1.0	17.0	13	13		1	1.0	5	0504	0003	303	22000.00	.017	363	27.93	72.61	5.59	65
												4	1001	0001	221	17400.00	.018	315	24.23	78.73	6.06	52
												4	0503	0003	43	12200.00	.093	1135	87.30	283.72	21.82	52
												4	0501	0003	157	11600.00	.025	296	22.73	73.89	5.68	52
ST						17.0						17						2108	162.18	124.02	9.54	
645AU	13.0	1.0	1.0	2	2.0	24.0	1	1		1	2.0	26	0493	0002	338	13500.00	.077	1038	1038.46	39.94	39.94	26
681 L	13.0	1.0	1.0	1	1.0	13.0	8	8		1	1.0	13	0482	0001	114	22000.00	.119	2509	313.60	192.98	24.12	104
682 L	13.0	1.0	1.0	2	2.0	24.0	6	6		1	2.0	26	1005	0003	124	16000.00	.210	2097	349.46	80.65	13.44	156
645SHL	13.0	1.0	1.0	2	2.0	24.0	7	7		1	2.0	26	0502	0003	65	11300.00	.400	4520	645.71	173.85	24.84	182
5931 SEM I	50.0	1.0	1.5	1	1.5	75.0	25	25		1	1.5	75	0485	0001	136	18300.00	.551	10092	403.68	134.56	5.38	1875
5942 SEM II	50.0	1.0	1.5	1	1.5	75.0	50	50		1	1.5	75	0504	0001	303	22000.00	.248	5446	108.91	72.61	1.45	3750
												75	1002	0001	101	0.00	.743	0	0.00	0.00	0.00	3750
ST						75.0						150						5446	108.91	36.30	1.45	
5953 SEM III	50.0	1.0	1.5	1	1.5	75.0	50	50		1	1.5	75	0494	0002	102	19000.00	.735	10294	205.88	137.25	2.75	3750
												75	0495	0002	158	13300.00	.475	6313	126.27	84.18	1.68	3750
ST						75.0						150						16607	332.15	110.72	4.43	
964 SEM IV	50.0	1.0	1.5	1	1.5	75.0	10	10		1	1.5	75	1005	0003	124	16000.00	.605	6048	604.84	80.65	8.06	750
												75	0482	0001	114	22000.00	.658	14474	1447.37	192.98	19.30	750
ST						75.0						150						20522	2052.21	136.81	27.36	
975 EM I	50.0	1.0	1.5	1	1.5	75.0	34	34		1	1.5	75	0499	0003	327	11900.00	.229	2729	80.28	36.39	1.07	2550
												75	0501	0003	157	11600.00	.478	5541	162.98	73.89	2.17	2550
												75	0504	0001	303	22000.00	.248	5446	160.16	72.61	2.14	2550
												75	0491	0001	241	12950.00	.311	4030	118.53	53.73	1.58	2550

```
+-------+-----+----+----+---+-----+-------+----+-----+-----+--+-----+-----+----+-----+-----+----------+---------+-----+-------+------+------+-----+
I       I     I    I    I   I     I       I    I     I     I  I     I     I    I     I     I          I         I     I       I      I      I     I
IFIU-I.I  (S)I(R)I(D)I(Y)I  (H) I  (PF) I(E) I(71)I(Z2)I GI(TB)I(TA)I(L) I(N)  I(X) I ( SA )   I   (PT)    I (C)  I ( CU )I  (CH) I  (AI) I(TIZ)I
I       I     I    I    I   I     I       I    I     I     I  I     I     I    I     I     I          I         I     I       I      I      I     I
+-------+-----+----+----+---+-----+=======+====+=====+=====+==+=====+=====+====+=====+=====+==========+=========+=====+=======+======+======+=====+
I       I     I    I    I   I     I       I    I     I     I  I     I   75I100I0001I  221I17400.00I     .339I  5905I 173.68I 78.73I  2.37I 2550I
I       I     I    I    I   I     I       I    I     I     I  I     I     I    I     I     I          I         I     I       I      I      I     I
I       I     I    I    I   I     I       I    I     I     I  I     I  375I    I     I     I          I         I  2365I 695.63I 63.07I  9.28I     I
I    ST I     I    I    I   I     I   75.0I    I     I     I  I     I     I    I     I     I          I         I     I       I      I      I     I
+-------+-----+----+----+---+-----+-------+----+-----+-----+--+-----+-----+----+-----+-----+----------+---------+-----+-------+------+------+-----+
I6986   I50.0I1.0I1.5I  1I  1.5I   75.0I  65I   65I     I 1I  1.5I   75I0500I0003I  298I17600.00I     .260I  3021I  46.47I 40.28I   .62I 4875I
ISem II I     I    I    I   I     I       I    I     I     I  I     I     I    I     I     I          I         I     I       I      I      I     I
+-------+-----+----+----+---+-----+-------+----+-----+-----+--+-----+-----+----+-----+-----+----------+---------+-----+-------+------+------+-----+
I673 L  I13.0I1.0I1.0I  2I  3.0I   26.0I  22I   22I     I 1I  2.0I   13I1016I0000I   13I      0.00I    1.000I     0I   0.00I  0.00I  0.00I  286I
I       I     I    I    I   I     I       I    I     I     I  I     I   13I0490I0001I   75I14800.00I     .173I  2565I 116.61I197.33I  8.97I  286I
I       I     I    I    I   I     I       I    I     I     I  I     I     I    I     I     I          I         I     I       I      I      I     I
I    ST I     I    I    I   I     I   24.0I    I     I     I  I     I   26I    I     I     I          I         I  2565I 116.61I 98.67I  4.48I     I
+-------+-----+----+----+---+-----+-------+----+-----+-----+--+-----+-----+----+-----+-----+----------+---------+-----+-------+------+------+-----+
I   TOT I     I    I    I   I     I   24.0I    I     I     I  I     I   26I    I     I     I          I         I  2565I 116.61I 98.67I  4.48I     I
I       I     I    I    I   I     I       I    I     I     I  I     I     I    I     I     I          I         I     I       I      I      I     I
+-------+-----+----+----+---+-----+-------+----+-----+-----+--+-----+-----+----+-----+-----+----------+---------+-----+-------+------+------+-----+
```

APPENDIX V

RECOMMENDED RESEARCH

1. Decision Theory and University Welfare
2. Professorial Activity Analysis
3. Audio-visual Production Functions and Costs
4. Evaluation of Student Effort (Time) in Different Universities
5. The Feasibility of the Critical University
6. Student Finance
7. Motivation to Attend University and University Programs
8. Previous Scholastic Experience of Incoming Students
9. The Linkage Between Quality of Research-Teaching
10. Operational Testing of Model for Student Accounting by Program
11. Research on Educational Achievement Particularly Where It May Have Important Economic Consequences.

BIBLIOGRAPHY

I. ECONOMIC THEORY AND SCIENTIFIC METHOD

Books

1. Arrow, K.J., Social Change and Individual Values. New York: John Wiley and Sons, 1951.

2. Cresson, André , Bergson. Collection Philosophes. Paris: Presses Universitaires de France, 1964.

3. Hills, R.J., The Concept of System. Eugene: Centre for Advanced Study of Educational Administration, University of Oregon, 1967.

4. Morgenau, H. and Smith, J.A., Philosophy of Physical Science, in Guy S. Metraux and François Crouzet (eds.), The Evolution of Science. New York: Mentor, 1963.

5. Popper, Karl R., Conjectures and Refutations. New York: Harper Torchbooks, 1968.

6. Rudner, R.S., Philosophy of Social Science. Englewood Cliffs: Prentice-Hall, 1966.

7. Wise, J.E., Nordberg, R.B., and Rietz, D.J., Methods of Research in Education. Boston: D.C. Heath Co., 1967.

Articles

8. Asimakopulos, A., "The Consumer Price Index". The Canadian Journal of Economics and Political Science, August, 1963.

9. Blaug, Mark, "The Productivity of Universities". Unit for Economic and Statistical Studies on Higher Education, reprint. London: London School of Economics and Political Science, 1968.

10. Boulding, Kenneth, "Economics as a Moral Science". American Economic Review, Volume LIX, number 1, March, 1969.

11. Carrese, Louis M. and Baker, Carl G., "The Convergence Technique: A Method for the Planning and Programming of Research Efforts". Management Science Volume 13, number 8.

12. Dorfman, R., "Operations Research", in Surveys of Economic Theory, Volume III, London: Royal Economic Society and American Economic Association, 1965. Pages 39-40.

13. Mishan, E.J., "A Survey of Welfare Economics", in Surveys of Economic Theory, Volume I, London: Royal Economic Society and American Economic Association, 1965.

Mimeographs

14. Chamberlain, Neil W., "Some Further Thought on the Concept of Human Capital". Graduate School of Business, Columbia University. 1968.

15. Judy, R., "Cost Theoretical and Methodological Issues". May, 1969.

II. EDUCATION

Books

16. A.G.E.U.M., Evaluation des Cours 1967/68. Montreal.

17. Gage, N.L. (ed.), Handbook of Research on Teaching. The American Educational Research Association. Chicago: Rand, McNally and Co., fifth printing, 1967.

18. Green, Donald Ross, Educational Psychology. Englewood Cliffs: Prentice-Hall. Foundations of Modern Psychology Series, 1964.

19. Kerr, Clark, The Uses of the University. New York: Harper & Row, 1966.

20. Kingsbury, Donald, Report of the McGill Student Society Project in Course Design. Montreal, 1968.

21. McGill University Arts and Science Undergraduate Society, Course Guide 1967-68. Montreal.

22. Robert, G.; Royer D; and Tellier, Y., La Dynamique des groupes appliqués dans une classe d'adultes. Québec: Ministère de l'Education et les Editions de l'Institut de Formation par le Groupe.

23. Thorndike, E.L., Educational Psychology. Columbia University, 1913.

Articles

24. Malott, Richard W. and Svinicki, John G., "Contingency Management in an Introductory Psychology Course for One Thousand Students". The Psychological Record, Volume 19. 1969.

25. Malott, Richard W., "Its Great to be Alive in the 20th Century". Folder, 1969.

Mimeographs

26. Geis, George L. "Premature Instruction". Paper for the McGill Centre for Learning and Development Conference, November 1969. Ann Arbor: University of Michigan, 1969.

27. Malott, Richard W., and Palm, James M., "Contingency Management Revisited". Unpublished.

28. Western Michigan University, "T.A. Manual and Grade Book for Psychology 150". Kalamazoo: 1970.

III. PROGRAM BUDGETING, SYSTEMS ANALYSIS AND COST ANALYSIS

Books

29. Fisher, G.H., The Role of Cost-Utility Analysis in Program Budgeting. Santa Monica, California: Rand Co., RM-4279. September, 1964.

30. Fisher, G.H., The World of Program Budgeting. Santa Monica, California: Rand Co., P-3361. May, 1969.

31. Hirsch, W.Z., Education in the Program Budget. Santa Monica, California: Rand Co., RM-4333-RC. January, 1965.

32. Judy, R. and Levine, J., A New Tool for Educational Administrators. Association of Universities and Colleges of Canada. Toronto: University of Toronto Press. 1965.

33. Kershaw, J.A., and McClellan, R.M., Systems Analysis and Education. Santa Monica, California: Rand Co., RM-2473. October, 1959.

34. McKean, Roland and Anshen, Melvin, Problems, Limitations and Risk of the Program Budget. Santa Monica, California: Rand Co., RM-4377-RC. January, 1965.

35. Novick, David (ed.), Program Budgeting. Cambridge: Harvard University Press. 1965.

36. Organization for Economic Cooperation and Development, Financing of Education for Economic Growth. Paris: 1960.

37. Organization for Economic Cooperation and Development, Program Budgeting and Cost Benefit Analysis in the Planning of Education. Paris: 1968.

38. Smithies, Arthur, A Conceptual Framework for the Program Budget. Santa Monica, California: Rand Co., RM-4271-RC. September, 1964.

39. Williams, Harry, Planning for Effective Resource Allocation in Universities. Washington, D.C.: American Council on Education, 1966.

Articles

40. Blaug, Mark, "Approach to Educational Planning". Unit for Economic and Statistical Studies on Higher Education, reprint. London: London School of Economics and Political Science, June 1967.

41. Kammerer, Gladys, "Program Budgeting: An Aid to Understanding". Gainesville: University of Florida, 1961.

42. McGrath, Earl J., "Memo to a College Faculty Member". Institute of Higher Education. Teachers' College, University of Columbia. Third printing, 1967.

Mimeographs

43. Boxus, L., Jadot, J., and Walckiers, P., "Essaie d'application des techniques PPBS à l'Université Catholique de Louvain." Louvain, 1969.

44. Hansen, B.L., "Brief of the Structure and Operation of the Operating Grants Formula for the Provincially Assisted Universities of Ontario 1967-68 Through 1969-70". Toronto: Committee of Presidents of Ontario Universities. May 1969.

45. Judy, R.W., "Simulation and Rational Resource Allocation in Universities". Paris: Organization for Economic Cooperation and Development. January, 1967.

46. Judy, R.W., "Systems Analysis Techniques in University Planning". Paris: Organization for Economic Cooperation and Development. DAS/EID/67.7, January 1967.

47. Judy, R.W. and Levine, J.B., and Wilson, R., "Systems Analysis of Alternative Designs of a Faculty". Toronto: 1969.

48. Khan, Abdul H., "The Concept of a University: An Ideological System VS. Social Reality". Paris: Organization for Economic Cooperation and Development. DAS/EID/69.29. Restricted.

49. Quade, E.S., "Systems Analysis Techniques for Planning-Programming-Budgeting". Santa Monica, California: Rand Co., P-3322. March, 1966.

50. Vaizy, J.D. and Cheswas, M., "The Costing of Educational Plans." UNESCO. 1967.

51. Weatherly, George, "Development and Application of a University Cost Simulation Model". Berkeley: Office of the Vice-President, Planning and Analysis, University of California. June 15, 1967.

52. William, Robert, "Administration of Academic Affairs". Ann Arbor: University of Michigan Press, 1961.

RESUME EN FRANCAIS

INTRODUCTION

Cette étude vise à apporter une certaine contribution à l'analyse des coûts et bénéfices de l'enseignement en milieu universitaire. Elle comporte, de plus, un examen des coûts de l'enseignement dans deux départements de chacune des universités McGill et Montréal.

Dans le chapitre I, nous présentons une discussion théorique de l'allocation des ressources dans le secteur public.

Dans le chapitre II, en nous inspirant de la littérature dans le domaine de la psychologie de l'éducation, nous tâcherons d'identifier les inputs et les outputs du processus d'éducation. Cette recherche se place dans le contexte de l'analyse des systèmes.

Dans le chapitre III, nous présentons le schéma comptable qui est utilisé subséquemment dans l'étude. Puis, après avoir énuméré les principaux éléments du Program-budgeting, nous passons en revue les diverses méthodes qui peuvent être utilisées dans l'évaluation des inputs et de leur coût. La structure comptable proposée est ensuite appliquée aux quatre départements étudiés. Nous illustrons enfin l'utilité et la flexibilité de cette structure comptable en l'appliquant à deux cours qui reposent sur des pédagogies nouvelles, un cours de mathématiques et un autre de psychologie.

Dans le chapitre IV, enfin, nous illustrons l'utilité et l'implication de notre schéma pour ce qui a trait aux prises de décisions intra-universitaires, inter-universitaires, et extra-universitaires.

Il est à noter que le seul coût comptabilisé dans cette étude est le traitement des professeurs. Cette limitation nous a été imposée par l'impossibilité d'obtenir des renseignements précis sur les autres éléments du coût total. Il nous faut cependant insister sur le fait qu'il serait théoriquement très désirable de tenir compte de tous les autres coûts de l'enseignement, ceci surtout à cause de la substituabilité qui existe entre les divers éléments des coûts totaux.

CHAPITRE I

ECONOMIQUE DE LA DISTRIBUTION DES RESSOURCES DANS LES UNIVERSITES DU QUEBEC.

I - Niveau global du financement des universités.

La solution du problème dépend de la possibilité de définir une fonction de préférence sociale qui reflèterait des facteurs économiques et culturels. Ceci est d'autant plus complexe dans le cas des dépenses des universités que, sous-jacents à cette question, se trouvent d'une part les problèmes liés au conflit entre générations et entre classes sociales, à l'absence de mécanisme de marché et à la difficulté de définir l'output des universités. D'autant plus difficile aussi dans la mesure où l'éducation apparaît à la fois comme consommation et comme investissement pour un individu et que la société toute entière bénéficie de la formation reçue par l'étudiant.

Bref, étant donné l'état des connaissances en "Economie de bien-être" et l'absence de fonction de préférence sociale bien déterminée, il nous faut conclure que l'allocation des dépenses publiques se fait nécessairement entre les divers secteurs à la lumière de critères qui sont loin d'être bien définis. Devant cette situation, les universités font face à deux possibilités qui ne sont peut-être pas mutuellement exclusives:

1) Définir leur propre fonction de préférence sociale, de laquelle elles déduisent leurs propres politiques et besoins. Ceci revient à dire que le secteur universitaire doit agir en fonction de sa propre perception des besoins de la société.

2) Utiliser de façon optimale les ressources qui sont mises à leur disposition, compte tenu des objectifs qui sont définis à l'extérieur du système universitaire.
Le niveau de satisfaction du système universitaire est déterminé à la fois par l'output final et par le processus de production.

Si cette assertion est fondée et si, de plus, on accepte que la satisfaction des autres secteurs de la société est aussi affectée par le processus de production et par l'output du milieu universitaire, il est alors nécessaire de maintenir une certaine consistance entre la satisfaction du système universitaire et la satisfaction sociale. Il y a trois possibilités de le faire:

a) La société impose ses volontés aux universités;

b) Les universités imposent leurs volontés collectives à la société;

c) Les sociétés et les universités s'engagent dans un processus de médiation et de compromis.

La première alternative est incompatible avec la liberté en milieu universitaire. La deuxième présuppose que l'université joue un rôle de premier plan. Il faut alors analyser les conditions qui permettraient l'existence de l'université critique. Il est difficile de se prononcer sur les possibilités de celle-ci. La troisième alternative semble être la plus vraisemblable.

II - La distribution des ressources.

Le problème de la distribution des ressources se pose dès qu'il y a plus d'une institution dans le milieu universitaire. S'il était possible d'examiner ce problème au niveau du système global, on pourrait dire que le système devrait viser à réaliser les outputs désirés au moindre coût par étudiant. Du point de vue économique, il faudrait alors avancer l'hypothèse que les diverses universités peuvent produire des étudiants équivalents, que les universités sont indifférentes en termes d'utilité entre différents processus de production et qu'elles sont, enfin, prêtes à choisir le processus le moins coûteux, s'il n'affecte pas le niveau de satisfaction de l'institution. Dans ce contexte, l'université ou la faculté ou le département ou le module qui aurait le moindre coût par étudiant recevrait la plus grande partie des sommes. Il apparaît cependant que le système universitaire n'est pas homogène et que la diversité est précisément l'une de ses caractéristiques. Les étudiants des divers campus ne sont pas équivalents, les coûts de leur formation ne sont pas identiques, il y a complémentarité entre la méthode de préparation des étudiants et la nature de l'output et il est enfin difficile de faire des comparaisons inter-personnelles d'utilité. Il est donc impossible de procéder à l'allocation des ressources selon ces critères.

D'autre part, les conditions "paretiennes" de maximisation de l'utilité, - selon lesquelles l'utilité du système total est augmentée seulement s'il est possible d'améliorer le niveau de satisfaction d'une unité sans diminuer celui d'aucune autre, - vont à l'encontre d'une homogénéisation des unités au plus bas niveau de coût par étudiant.

De plus, les utilisations possibles de l'analyse coûts-bénéfices en milieu universitaire sont d'une application difficile à cause de la subjectivité qui est impliquée dans la détermination de certains coûts et bénéfices.

L'utilisatisation d'une structure comptable qui identifie les inputs, les outputs et les programmes qui les produisent aura des implications pour le problème précité, en ce sens que les relations deviennent alors identifiées comme elles ne l'ont jamais été auparavant. La meilleure information possible sur le plan des coûts permettra d'examiner et de choisir plus rationnellement les alternatives entre lesquelles les parties impliquées seront indifférentes. Il nous faut ajouter que l'analyse des coûts dans les diverses institutions aura pour effet de faciliter la rationalisation dans l'utilisation des ressources et de permettre une redistribution de celles-ci entre les institutions. Néanmoins, il faut encore insister sur le fait que les bénéfices ne sont pas parfaitement mesurables et qu'en conséquence une analyse coûts-bénéfices ne nous donnera que des résultats aléatoires.

CHAPITRE II

LE PROCESSUS D'EDUCATION A LA LUMIERE DE L'ANALYSE DES SYSTEMES.

On retrouve dans ce chapitre une présentation des caractéristiques générales de l'analyse des systèmes et de son application possible au processus d'éducation. Dans ce type d'analyse, on est amené à présenter le processus d'éducation comme un système de production et comme étant une démarche impliquant une interaction entre les professeurs, les étudiants et le milieu dans le but de produire un output. On s'interroge sur la fonction de production qui permet de relier ces facteurs. Ceci nous amène à examiner les mécanismes de transmission des connaissances, de développement des aptitudes en négligeant le développement de la personnalité de l'étudiant. L'application de l'analyse des systèmes au processus d'éducation ne permet pas de déterminer qui devrait fixer les objectifs du système et, de plus, à cause de sa nature même, l'analyse des systèmes en soi ne contribue pas à l'homogénéisation du processus d'éducation car, en effet, il s'agit d'un type d'analyse qui permet de mettre en relief la valeur relative de diverses méthodes alternatives.

Après cet exposé théorique du concept de système, il nous faut identifier les variables qui entrent en jeu dans le processus d'éducation.On retient trois inputs principaux: le temps, les professeurs et les étudiants. Ces inputs sont eux-mêmes agencés en terme d'activités, tels que le cours magistral, la conférence, le laboratoire, la correction, etc... L'output est constitué essentiellement par la modification des connaissances et des aptitudes de l'étudiant. Pour mesurer le facteur temps, nous utilisons le nombre d'heures durant lesquelles professeurs et étudiants sont en présence. Il faut noter que cette mesure ne tient compte que des heures d'enseignement qui sont formellement prévues au calendrier de l'étudiant. Ainsi, les discussions entre professeurs et étudiants ou entre étudiants, discussions qui ont lieu de façon très irrégulière et qui contribuent au processus d'éducation ne sont pas comptabilisées. De plus, en ne tenant compte que des heures de contact, le temps que le professeur consacre à la préparation, l'administration et la correction n'est pas comptabilisé. Enfin, l'unité de temps ne permet pas de tenir compte de la qualité de ce qui est produit durant cette unité de temps.

Le nombre de professeurs, leurs caractéristiques ainsi que leurs traitements sont des variables relativement facile à obtenir. Les statistiques utilisées proviennent du fichier des professeurs de la Conférence des Recteurs. Il faut noter que le traitement d'un professeur ne constitue pas une indication satisfaisante de son efficacité. La mesure de la productivité d'un professeur entraîne toute une suite de problèmes et nous passons en revue les difficultés qui sont inhérentes à toutes les tentatives qui ont pour but une évaluation du travail du professeur.

L'étudiant entre à l'université avec certaines caractéristiques. Son séjour à l'université va modifier ses caractéristiques. Il faudrait pouvoir mesurer les changements qu'apporte l'enseignement universitaire.

Mais de nombreux autres facteurs, en plus des heures de contact, entrent en ligne de compte dans les changements qui s'effectuent dans les capacités de l'étudiant au cours du processus de formation. L'absence de bonnes caractéristiques descriptives de l'étudiant et de bonnes mesures des changements qui surviennent au cours du processus, rendent difficile l'application de l'analyse coût-bénéfice dans ce domaine. Cependant, en nous inspirant de la littérature en psychologie de l'éducation, nous proposons certains facteurs qui pourraient servir à l'évaluation de l'étudiant et donc de l'output du milieu universitaire. Soulignons toutefois qu'il faudrait, pour que l'étude soit complète, tenir compte des facteurs héréditaires et génétiques, des facteurs qui décrivent les capacités intellectuelles de l'étudiant, des facteurs émotionnels et culturels.

Vient ensuite l'exposé des implications pédagogiques qui résultent de la variation du nombre d'étudiants par cours. On admet généralement que l'efficacité de l'enseignement est inversement proportionnelle aux nombres d'étudiants par cours. Il serait donc intéressant de pondérer et comparer les variations dans les coûts unitaires avec les variations dans l'efficacité des cours.

En conclusion à ce chapitre sur la façon dont les connaissances sont acquises et sur les différentes modalités de transmission des connaissances, il nous apparaît très difficile de faire des généralisations. En effet, le nombre important de variables qui entrent dans chaque situation, l'hétérogénéité des caractéristiques personnelles des étudiants ainsi que de leur préparation préalable avant l'entrée à l'université rend le problème excessivement complexe.

Il nous semble donc qu'il nous sera impossible de quantifier correctement les bénéfices de l'éducation. Essayons cependant de comptabiliser correctement les coûts.

> "It is seducing to equate the unknown with the non-existent and say that it makes no difference after all let us do what costs the least".

Les données qui sont utilisées dans l'étude de coûts sont le nombre de professeurs et leur traitement et le nombre d'étudiants comptabilisés par cours-séminaires.

Bien que restreintes, ces données permettront quand même d'établir les coûts relatifs de diverses méthodes d'enseignement. Et, pour ce faire, nous proposons dans le chapitre suivant un modèle comptable.

CHAPITRE III

LE MODELE COMPTABLE

Techniques budgétaires.

Le flux des revenus et dépenses qui est présenté dans les budgets dépend de la période de temps retenue, de l'unité de décision visée et du choix des catégories retenues pour indiquer le flux des fonds dans l'unité de décision retenue. Dans le milieu universitaire, on distingue des budgets fiduciaires et des budgets par programme. Dans la première catégorie de budgets, on comptabilise des dépenses selon divers postes, à savoir, traitement, équipement, etc... Cette comptabilisation s'avère utile pour fin de contrôle mais pas pour fin de décision et de planification du milieu universitaire. Habituellement, les budgets fiduciaires des universités couvrent une courte période de temps et n'indiquent pas très bien les dépenses d'enseignement et de recherche, donnent peu de renseignements sur les dépenses par cycle d'études et ne permettent d'ailleurs pas l'estimation des coûts de façon claire. En somme, une des lacunes principales des méthodes de budgets conventionnelles utilisées dans les universités est de ne pas être axée sur les objectifs de l'université.

Par contre, les budgets par programme ont pour objectif principal de rattacher divers dépenses et coûts à des programmes spécifiques. On retrouvera sur le tableau I les principales différences entre les budgets fiduciaires et les budgets par programme.

TABLEAU I

THE FOCUS OF PROGRAM AND CONVENTIONAL FIDUCIARY BUDGETS.

Program Budgeting	Fiduciary Budgeting
Alternative ways to achieve university goals and objectives.	Sources of funds.
Major programs in teaching and research.	Constraints on receipt and expenditure of funds.
Resource requirements explicitly related to each program and sub-program.	Aggregates of expenditure on Administration Teaching and Research Maintenance Student Services.
"True" costs of major programs and program elements.	Legal and administrative accounting for funds.
Marginal and opportunity costs.	Average cost ratios.
Long time periods.	Short time periods.
Level of activities "produced".	Purely fiscal matters.

Source: Williams, Harry, Planning for Effective Resource Allocation in Universities, Washington, D.C., American Council on Education. 1966. Pp. 15.

A partir du budget par programme, il est possible d'analyser les implications en termes de coûts de méthodes alternatives d'enseignement et de programmes différents dans le milieu universitaire. La définition du programme est un des problèmes les plus importants à résoudre. Boxus, Jadot et Walckiers, dans leur "Essai d'application des techniques P.P.B.S. à l'Université Catholique de Louvain", présentent comme suit leurs définitions de programme.

EXEMPLE DE PROGRAMME

		OBJECTIF SCIENCES ECONOMIQUES	
OBJECTIFS	Enseignement des Sciences Econom.		Recherches
PROGRAMMES	1er cycle	2ème cycle	3ème cycle
SOUS-PROGRAMMES	Economie Générale	Economie Mathématique	
ELEMENTS DE PROGRAMME	Cours d'écon. politique	Cours de Macro-écon.	Cours de Recherche Opérationnelle

"Cette présentation permet d'analyser la combinaison des ressources à mettre en oeuvre pour "produire" un certain nombre de diplômes dans chaque cycle et orientation. Le choix des diverses orientations comme sous-programmes est peut-être plus stimulant pour la réglexion que la traditionnelle division en candidatures, licences, etc...Cette nouvelle formule permet d'apprécier la complémentarité des éléments de programme. Elle fait saisir la nécessité de disposer d'une banque d'information fournissant le détail des inscriptions des étudiants non seulement par discipline, par cycle, ou par orientation mais également par cours".(1)

Pour les fins de la présente étude, une unité formelle d'enseignement (UFE) est utilisée comme unité d'analyse. Si l'UFE est un cours, et que ce cours comprend des cours magistraux et des séminaires, on dira que ceux-ci sont des activités de l'UFE. Si, par contre, l'unité formelle d'enseignement est un séminaire qui a lieu toutes les semaines, alors l'UFE comporte une seule activité. Dans ce cas, l'UFE et l'activité sont identiques.

Si on embauche des correcteurs pour corriger les examens d'un cours, et qu'on les rémunère, alors l'UFE se décomposera en deux activités. Par contre, si c'est le professeur lui-même qui fait la correction et qu'il n'est pas rémunéré explicitement pour cela, il n'y a qu'une activité.

---

(1) Boxus, Jadot, Walckiers, pp.33, "Essai d'application des techniques du P.P.B.S. à l'Université Catholique de Louvain", 1969.

Un programme est un ensemble d'unités formelles d'enseignement. Les combinaisons d'unités formelles d'enseignement servent à des fins administratives et à des fins pédagogiques. Si un programme est interdisciplinaire et qu'un département, ou un module a une part plus importante que les autres, il serait peut-être désirable de présenter alors deux formats comptables: un pour fins administratives des départements, l'autre pour fins pédagogiques du programme. Le modèle comptable que nous proposons a été préparé de façon à permettre, d'une part, aux départements de préparer leurs budgets pour fins d'enseignement, et d'autre part, de comptabiliser les coûts des programmes d'enseignement. Ceci est rendu possible parce que l'unité formelle d'enseignement a été choisie au niveau le plus désagrégé possible. Dans le modèle proposé, un input est tout simplement une observation. Quant à l'output il est un renseignement qui résulte d'une manipulation arithmétique d'au moins deux inputs. Par exemple, dans le format comptable, si X et Y sont deux inputs,

$Z = X. Y$ est un output.

(a). Inputs*.

1. Activités.

(L) Cours ~~marginaux~~ MAGISTRAUX.

(A) Laboratoires

(C) Conférences

(D) Groupes de discussions

(S) Séminaires

(M) Fonctions administratives qui découlent de l'enseignement et qui sont rémunérées à part.

(E) Fonctions pédagogiques qui découlent de l'enseignement et qui sont financées à part.

Une activité se décompose en séances. Chaque fois qu'un étudiant se présente à une activité et qu'il fait quelque chose de différent de ce qu'il a fait précédemment, on dit qu'il assiste à une séance.

Une classe est toute activité qui regroupe des étudiants et des professeurs.

---

* Les lettres et les chiffres entre parenthèses sont ceux qui figurent dans le Graphique I (se trouvant à l'intérieur de la couverture) qui illustre la forme du modèle comptable. Les chiffres qui identifient chacun des inputs correspondent aux titres des colonnes du Graphique I. Chacun des symboles est identifié dans la colonne appropriée. La façon de calculer chacun des outputs, à partir des inputs, est aussi identifiée par une formule que l'on retrouve dans chacune des colonnes du Graphique I.

2. Le temps.

(1) Nombre de semaines par année que dure l'activité.

(2) La séquence, c'est la fréquence de la séance; la séance a lieu toutes les semaines, deux fois par semaine, toutes les deux semaines...etc.

(3) La durée de chacune des classes.

(4) Le nombre de séances par séquence. (Par exemple s'il y a deux heures de cours d'affilée durant une semaine, il y a deux sessions dans cette séquence).

3. Etudiants.

(7) Le nombre d'étudiants inscrits dans l'activité.

(8-9) Le nombre d'inscrits qui participent à l'activité à un moment donné.

4. Professeurs.

(13) Le numéro matricule du professeur responsable de chaque activité.

(14) Le rang du professeur.

(15) Le traitement brut du professeur excluant les avantages sociaux, par heure ou par année, selon le cas.

(b) Outputs.

1. Physiques.

(5) Le nombre d'heures par séquence auxquelles assiste chaque étudiant.

(6) Le nombre d'heures par année auxquelles assiste chaque étudiant.

(11) Le nombre d'heures d'enseignement par année, par activité.

(12) Le nombre d'heures d'enseignement par séquence pour chaque activité.

(17) Le pourcentage du fardeau du professeur que représente chaque activité.

2. Financier.

(18) Le coût total par année, par activité.

(19) Le coût par étudiant, par année, par activité.

(20) Le coût par heure d'enseignement par activité.

(21) Le coût par heure, par étudiant qui participe à l'activité.

3. Auxiliaires.

(22) Facteur de pondération qui est utilisé pour fins d'analyse de la variance des coûts, par professeur, par heure.

L'analyse des coûts et la préparation des budgets prévisionnels dans l'université exigent que nous soyons en mesure de prévoir les inscriptions en cours, par unité formelle et par activité dans l'institution. Comme nous l'avons mentionné plus haut, on peut comptabiliser les coûts, soit par unité administrative, soit par programme. La comptabilité par unité administrative est nécessaire pour savoir quelles sont les ressources que l'on doit mettre à la disposition des unités administratives pour leur permettre de se conformer aux exigences des différents programmes qu'elles offrent et des services qu'elles fournissent. La comptabilité par programme indique simplement le coût de chaque programme. La somme des distributions des divers départements à un même programme devrait être identique au coût du programme.

Pour aller plus loin, il vous faut une taxonomie des programmes et des activités à l'intérieur des programmes. Faisons l'hypothèse que tout étudiant doit suivre au moins une unité formelle d'enseignement dans un département et au plus un maximum (M) d'unités formelles d'enseignement telles qu'impliquées par son programme d'études. A titre d'exemple, faisons l'hypothèse que le nombre maximum d'unités formelles d'enseignement que l'étudiant peut prendre dans un département est 4. On désigne ce nombre par le symbole "r" qui peut varier de 1 à 4.

Les programmes se distinguent des uns des autres selon l'emphase relative que l'étudiant place entre diverses disciplines. On peut classifier les inscriptions des étudiants par grandes disciplines (symbole "d") et par le nombre d'U.F.E.: "r" que chaque étudiant prend dans la discipline.

TABLEAU III

Champs de connaissances

r	d_1	d_2	d_3	E
1	300	400	200	900
2	250	150	200	600
3	75	100	125	300
4	50	100	150	300
TOT.	675	750	675	2100

Champs de connaissances

r_1d_1	r_1d_2	r_1d_3
r_2d_1	r_2d_2	r_2d_3
r_3d_1	r_3d_2	r_3d_3
r_4d_1	r_4d_2	r_4d_3

Dans le Tableau III, à titre d'exemple, nous classifions 2100 étudiants (E) par disciplines majeures (d_1 à d_3) et par nombre d'unités formelles d'enseignement qu'ils prennent par département, dans une année donnée. Par exemple r_3 d_3 nous signale que 125 étudiants sont inscrits dans la discipline d_3 et suivent chacun 3 unités formelles d'enseignement dans le département impliqué.

Chaque carré reliant un "r" et un "d" est un champ de connaissances, qu'on désigne par $r_x d_y$. Un examen du contenu d'unités formelles d'enseignement par champ de connaissance nous permet de voir l'emphase relative entre les disciplines, d'une part et le degré de spécialisation d'autre part. Il est possible de préparer le tableau de la distribution du nombre d'unités formelles d'enseignement disponible dans chaque discipline (Tableau IV).

TABLEAU IV

Distribution des U.F.E. par discipline

Champs de connaissances	Nombre d'U.F.E. par département
r_3d_2	6
r_3d_3	7
r_4d_1	4
r_3d_2	7
r_4d_3	10
r_1d_1	2
r_1d_2	4
r_1d_3	8
r_2d_1	3
r_2d_2	5
r_2d_3	4
r_3d_1	3

Par exemple, $n = 5$ pour r_2 d_2, signifie qu'un étudiant peut choisir entre les cinq unités formelles d'enseignement qui sont offertes dans la discipline d_2.

"n" est le nombre d'unités formelles d'enseignement parmi lesquelles chacun des 150 étudiants inscrit dans le champ de connaissance $r_2\ d_2$ a deux U.F.E., il découle que le nombre moyen d'inscrits par unité formelle d'enseignement est: (e).

$$e = \frac{E_{r_x\ d_y} . r}{n}$$

où $E_{r_x d_y}$ est le nombre d'inscrits dans le champ $r_x d_y$.

Par exemple, dans le champ de connaissance $E_{r_2 d_2}$, nous savons qu'il y a 150 inscrits, 5 U.F.E. disponibles $(n=5)$ et que chaque étudiant en a choisi 2 $(r=2)$. "e" est donc égal à 60. Ceci suppose une distribution uniforme des étudiants entre 5 différences U.F.E. offertes.

Afin de déterminer les inscriptions totales par unité formelle d'enseignement, il faut connaître quelles sont les U.F.E. disponibles dans chacun des champs de connaissances. Le Tableau V nous donne les renseignements.

TABLEAU V

Distribution des U.F.E. par champs de connaissances

Champ de connaissances	r_1d_1	r_1d_2	r_1d_3	r_2d_1	r_2d_2	r_2d_3	r_3d_1	r_3d_2	r_3d_3	r_4d_1	r_4d_2	r_4d_3
UFE 1	x	x				x						x
2			x					x				
3		x	x								x	x
4				x		x						
5	x		x					x				x
6				x				x		x	x	
7		x							x			x
8				x					x	x		
9			x			x					x	x
10		x				x				x		
11			x					x			x	x
12					x				x		x	
13			x				x	x				x
14					x		x					
15			x						x		x	x
16					x			x			x	
17			x				x			x		x
18					x				x			
19					x				x			x
20									x			

Les inscriptions totales par unité formelle d'enseignement, sont égales à la somme des inscriptions à cette U.F.E. par champ de connaissances. Par exemple l'U.F.E. (1) se retrouve dans les champs de connaissances r_1d_1, r_1d_2, r_2d_3, et r_4d_3.
L'inscription totale dans l'U.F.E.: 1 sera égale à l'inscription dans l'U.F.E. (1) de r_1d_1 plus l'inscription dans l'U.F.E. (1) dans r_1d_2...etc. Faisons l'hypothèse que U.F.E.$_1$ est un cours de sciences sociales et que d_3 est une discipline scientifique. Les étudiants du champ de connaissances r_2d_3 suivent deux unités formelles d'enseignement dans la discipline scientifique. Les étudiants pour qui M est supérieur à 2 peuvent, par exemple, prendre l'unité formelle d'enseignement 1.
De façon générale, pour déterminer le nombre d'étudiants qui n'appartiennent pas à la discipline de l'U.F.E. dans laquelle ils sont inscrits, il faut classifier les étudiants selon le champ de connaissances et M. Dans tous les cas où $r > M$ c'est-à-dire dans tous les cas où le nombre d'U.F.E. choisis par un étudiant est plus grand que le nombre d'U.F.E. offerts dans la discipline, il faut considérer la valeur $D = r-M$. "D" est le nombre d'U.F.E. que l'étudiant prend dans une autre discipline que la sienne plus dans un champ de connaissances donné. Il y a n d'unités

formelles d'enseignement extra-disciplinaires parmi lesquelles l'étudiant aura eu à choisir D. Le nombre moyen d'étudiants inscrits dans une U.F.E. extra-disciplinaire est:

$$e = \frac{E_{r_x d_y} . D}{n^*} \quad (2)$$

L'application de la formule 2, permet de déterminer le nombre moyen d'inscriptions extra-disciplinaires par unité formelle d'enseignement. L'unité formelle numéro 1 de notre département hypothétique dessert quatre champs de connaissances, à partir de trois disciplines majeures. Le partage des coûts entre les départements, les champs de connaissances ou les disciplines peut être opéré à partir des renseignements obtenus par les équations (1) et (2). Le coût départemental est le coût total de l'unité formelle d'enseignement. Le coût par champ de connaissances est le coût unitaire par inscription par unité formelle d'enseignement multiplié par le nombre d'inscriptions dans chacune des unités formelles d'enseignement. Le coût unitaire par étudiant (CU) dans n'importe quel champ de connaissance peut être déterminé en faisant la somme des CU pour chacune des unités formelles d'enseignement auxquelles il est inscrit. Le coût par discipline (d) est la somme des coûts par champ de connaissances servi par la discipline: dans notre exemple le coût de d_1 est la somme des coûts encourus dans les champs de connaissances r_1d_1, r_2d_1, r_3d_1, et r_4d_1;

Une fois le nombre d'inscriptions connu (e) par unité formelle d'enseignement (U.F.E.) on peut déterminer le nombre "z" d'étudiants qu'il y aura à chaque séance de cours.

Connaissant le nombre de groupes d'étudiants, on peut déterminer le nombre d'enseignement requis par séquence de cours.Tb). Le "b" détermine la séquence de participation de l'étudiant à la session, c'est-à-dire à savoir si l'étudiant assiste à la session, chaque semaine, toutes les deux semaines ou tous les mois. On peut voir cette valeur à la colonne 2 du Graphique I. On détermine la valeur de "Tb" à partir des renseignements que l'on trouve dans les colonnes 5 et 10 du Graphique I, ce sont:

(a) $h = d.y$

(b) $Tb = g.h$

où "d" est la durée en heures d'une session)colonne 3) et "y" le nombre de sessions par période (colonne 4).

En multipliant le nombre d'heures par période par "g", le nombre de groupes, on obtient la valeur de "Tb". On obtient le nombre d'heures de contact par année, par activité, en multipliant "Tb" par "b" et par "s", "b" étant la période de séquence et "s" le nombre de semaines sur lequel s'échelonne l'activité. Ceci nous donne le total annuel "Ta", qu'on retrouve à la colonne 12 du Graphique I. "Pe" qu'on retrouve à la colonne 6 est le nombre d'heures de contact durant lesquelles l'étudiant assiste à une activité dans une année. "Pe" résulte de la multiplication de s.b.h. La colonne 17 nous donne "Pt" qui est la fraction de la charge totale du professeur que représente une activité, "Pt" est obtenu en divisant "Ta" par x, le nombre d'heures d'enseignement annuel par professeur. S'il y a plus d'un professeur impliqué dans l'unité formelle d'enseignement, la valeur de "Pt" est calculée pour chacun d'entre eux.

Le coût total des traitements par activité "C" est obtenu en multipliant la fraction "Pt" par le traitement du professeur.

Les renseignements contenus dans les colonnes 19-22 du Graphique I, sont obtenus de la façon suivante:

Colonne 19, coût unitaire par étudiant (CU) = C/e.

Colonne 20, coût unitaire par heure de contact (CH) = C/Ta par professeur.

Colonne 21, coût unitaire par heure par étudiant (A) dans l'activité = CH/z, ou CU/Pe. $A = \frac{CH}{z} - \frac{CU}{Pe}$

puisque $\frac{CH}{z}$ et $\frac{CU}{Pe}$ sont tous deux égaux à $\frac{C}{Pe.g.z} = \frac{C}{Pe.e} = A.$

Colonne 22, facteur de pondération = T.x.

Le facteur de pondération permet de déterminer le nombre pondéré moyen d'étudiants par heure de contact par professeur selon la formule

$$\frac{T_i z_i}{T_e}$$

où "i" désigne une activité, "e" est le professeur, T est égal à TA, "z" égale le nombre d'étudiants par session.

Ceci nous semble une meilleure mesure du rapport entre le nombre de professeurs et d'étudiants que le rapport traditionnel professeurs-étudiants.

La somme des coûts à divers niveaux d'aggrégation s'obtient en additionnant les valeurs de C selon le niveau d'aggrégation désiré. Au niveau de chaque activité, on fait la somme de TA afin d'obtenir le sous-total de TA pour l'activité, et on fait la somme de C qui nous donne un sous-total de C, on divise C par "e" afin de dériver un sous-total CU et enfin on divise le sous-total C par Ta afin d'obtenir le sous-total CH.

Au niveau de l'unité formelle d'enseignement U.F.E., on additionne les sous-totaux de Ta afin d'obtenir le Ta total, on fait de même pour les sous-totaux de CU afin d'obtenir le CU total; on divise ensuite C total par Ta total afin d'arriver à dériver le CH moyen, et on divise enfin le CU total par Pe total afin de déterminer le A moyen. Le budget départemental s'obtient en faisant la somme des coûts de toutes les unités formelles d'enseignement qu'il supporte.

Quelques commentaires relatifs à certaines variables qui entrent en ligne de compte dans laplanification de l'enseignement nous semblent nécessaires. Il nous paraît, par exemple, important de distinguer entre le nombre d'étudiants inscrits et le nombre qui assiste en moyenne aux cours, aux séminaires ou à l'activité, ceci pour fins de planificatim des espaces.

Signalons que la notion "heures de contact" est une mesure approximative qui recouvre une réalité plus complexe qui inclut, entre autres, la préparation des cours, l'administration des examens, la correction, la recherche, les services communautaires, etc... Quoique l'étude du calendrier des activités des professeurs ou des étudiants n'ait pas été abordée dans cette étude, nous pensons qu'il s'agit là d'une priorité qui permettrait de faire des analyses de coûts de l'enseignement beaucoup plus adéquates. Il faudrait, entre autres, s'interroger sur les incidences politiques départementales à ce sujet.

Dans la détermination en ce qui concerne les coûts lorsque ceux-ci sont élevés dans une unité formelle d'enseignement, on peut avancer l'hypothèse que le professeur consacre du temps à d'autres activités. Ainsi, les coûts d'enseignement relativement élevés sont le reflet de l'importance de la recherche plutôt que d'une utilisation inefficace des professeurs.

La méthode comptable proposée a cependant l'avantage d'être appliquée de façon homogène à tous, ce qui permet d'analyser de façon plus valable les coûts relatifs des activités même si les coûts absolus sont incertains. Afin d'améliorer les résultats et tirer les meilleures conclusions d'une analyse de ce genre, nous suggérons une étude par échantillon du calendrier des activités du professeur afin de déterminer la proportion du temps qu'il consacre à l'enseignement, la recherche, l'administration, les services communautaires. Un autre projet pourrait être la définition et la classification de la recherche de façon à permettre les comparaisons de la valeur relative de l'effort dépensé dans l'enseignement et la recherche.

Nous avons notre schéma comptable,-en guise d'illustration,- d'un des départements de la faculté des sciences de l'Université McGill.*

---

*. L'analyse détaillée des coûts se trouve dans le texte original à partir de la page 162.

Le coût total de l'unité formelle d'enseignement impliqué est de $112,905. Le coût par étudiant est de $ 89.62. Le coût moyen par heure d'enseignement de $ 33.06. L'usage des démonstrateurs a permis de résuire considérablement les coûts par étudiant dans cette unité formelle d'enseignement. L'application du modèle comptable dans ce département où les méthodes pédagogiques sont différenciées a fait ressortir sa flexibilité d'application. En effet, il a fallu tenir compte du fait qu'on utilise la télévision en circuit fermé dans cette unité formelle d'enseignement.

Dans la partie III du chapitre, nous nous servons du modèle comptable pour calculer le coût de l'enseignement en 1968-69 dans trois autres départements de deux universités. Cet exercice permet de comparer les coûts absolus et relatifs par départements, par université. On ne peut cependant tirer aucune implication politique de ces résultats. Pour qu'ils puissent nous servir il faudrait avoir une meilleure connaissance des objectifs pédagogiques et des bénéfices reliés aux divers niveaux de coûts.

Notre étude porte sur toutes les activités régulières d'enseignement des étudiants de premier, de deuxième et de troisième cycles. Par "régulières", nous entendons tous les enseignements qui conduisent à l'obtention d'un diplôme et qui sont donnés soit dans la matinée soit dans l'après-midi, durant les deux semestres réguliers de l'année. Une enquête spéciale nous a permis de compléter les renseignements pour ce qui est des démonstrateurs et autre personnel affecté à l'enseignement. Une longue analyse de ces données nous permet d'arriver aux résultats suivants. Le coût unitaire par étudiant, par heure, par unité formelle d'enseignement (A), en sciences sociales est plus élevé que celui en sciences malgré le fait que le coût total par U.F.E. "C", soit moins élevé en sciences sociales qu'en sciences. Ceci est dû au fait que les inscriptions en sciences sociales sont moins nombreuses que dans les facultés de sciences. Le "A" à McGill est moins élevé que celui de Montréal bien que le "C" à McGill soit plus élevé que celui de Montréal, ceci à cause du fait que les inscriptions sont plus nombreuses à McGill qu'à Montréal.

Il semble donc, du moins lorsque seuls les traitements sont pris en considération, que la façon de diminuer les coûts par étudiant serait d'augmenter le nombre d'étudiants plus que proportionnellement au coût total.

Cette méthode est toutefois limitée, du fait qu'on ne peut augmenter comme on veut le nombre des étudiants, surtout au niveau du deuxième et du troisième cycles.

La section IV du Chapitre III, nous démontre la flexibilité du système comptable proposé en l'appliquant à des structures pédagogiques très différentes. Nous analyserons un cours de mathématiques et un de psychologie. La désagrégation de l'U.F.E. en activités permet d'adapter le schéma comptable à une grande variété de structures pédagogiques.

Rappelons que la qualité de l'output ou de l'enseignement est en partie fonction de la méthode d'enseignement utilisée. On fait de plus remarquer à ce sujet, qu'il est aussi difficile de comparer en coûts afférents à deux outputs différents que de mesurer l'inflation à l'aide d'un indice de prix. Les deux souffrent de limitations assez considérables.

On retrouve dans l'appendice I une description détaillée de la méthode d'enseignement des mathématiques mise au point par Monsieur Donald Kingsbury, du département de Mathématiques de l'Université McGill. On applique le schéma comptable à cette nouvelle pédagogie. Dans cette structure d'enseignement, il n'y a pas de cours magistraux. L'étudiant reçoit d'un coordinateur un ou plusieurs ensembles de documents traitant des aspects particuliers de la discipline. Des conseillers mis à la disposition de l'étudiant l'assistent dans l'étude de ces documents. Il se présente ensuite à un examen dont il discute les résultats avec le conseiller et, s'il réussit, il se présente à nouveau au coordinateur afin de recevoir d'autre documents portant sur d'autres aspects de la discipline. On retrouvera dans la partie IV de ce chapitre une description détaillée de cette structure d'enseignement. On y fait aussi l'état des hypothèses qu'il a fallu faire, afin d'adapter le modèle comptable à cette nouvelle structure d'enseignement, hypothèses qui ont permis d'estimer que le cours nécessiterait 907 heures d'activités, que son coût annuel serait de $ 8548.80, que le coût moyen par étudiant serait de $ 85.49, et que le coût horaire moyen pondéré serait de $ 9.31. On fait ensuite état des coûts de l'enseignement traditionnel de la même matière, ce dernier nécessiterait 156 heures de cours avec un coût annuel de $ 5595.00, un coût moyen par étudiant de $ 75.95, et un coût horaire pondéré de $ 48.69. Le tableau CI nous fait état des coûts et des bénéfices relatifs aux méthodes d'enseignement.

TABLEAU VI

COMPARATIVE COST-BENEFIT SCHEDULE

RESOURCE LOADS AND ASSOCIATED COSTS	MLC	LECTURE SYSTEM
1. Total workload	907 hours	156 hours
2. Professorial time	182 hrs. (7/pge x 26 wks)	52 hours
3. Other instructors	725 hrs. (907 - 182)	104 hours
4. Ratio 2/3	.25	.5
5. Total cost	$8548.80	$7595.00
6. Average cost/student	$85.49	$ 75.95
7. Weighted average cost/hour	$ 9.31	$ 48.69

BENEFITS* Il s'agit d'aspects non quantifiables.

1.		slightly cheaper
2.	paced to individual needs	
3.	individual attention where needed	some students may get individual attention
4.	valuable training for instructors	
5.	credit recorded according to conceptual accomplishment rather than according to numbers that inform on competence with much less precision.	
6.	competence standards and test procedure positively reinforce motivation	
7.	students only credited for competence, not partial incompetence	some students wil develop competenc
8.	efficiency of learning materials maximized by constant feed-back and re-design	
9.	learning materials may be publishable with royalties.	

Dans la deuxième partie de cette section du Chapitre III, la structure comptable proposée pour l'analyse des coûts de l'enseignement est appliquée à un cours d'introduction à la psychologie qui a été donné à l'Université Wester Michigan. Cette analyse a été possible grâce à la coopération du professeur Mallot qui est responsable de ce cours.

Le cours de psychologie dont il est question rompt avec la tradition en ce sens que le rôle du professeur Mallot est très différent de celui d'un professeur qui enseigne un cours traditionnel en psychologie. On retrouvera dans le texte original une description des caractéristiques pédagogiques du cours de psychologie, une description des activités des étudiants et des professeurs dans cette structure et une analyse des coûts de fonctionnement de l'enseignement de la psychologie selon cette méthode. On y constatera, entre autres, qu'il y a une délégation de l'enseignement au niveau des étudiants du deuxième et du troisième cycles. On y fait une utilisation très poussée de diverses techniques d'évaluation afin d'améliorer la performance des étudiants et des professeurs ainsi que l'utilité des questions dans les questionnaires d'examens.

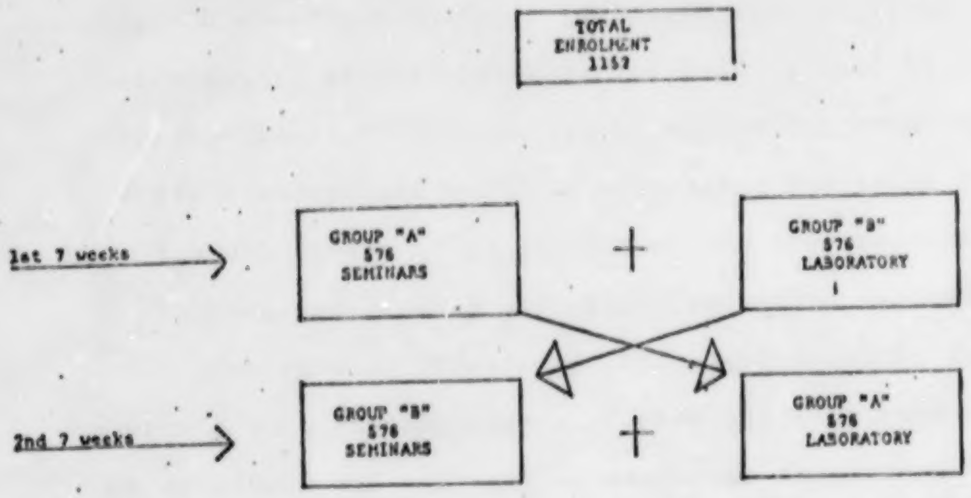
Les étudiants assistent à des séminaires d'une heure par jour, quatre jours par semaine, pendant sept semaines consécutives par semestres. Six groupes de quatre étudiants se réunissent durant chaque séance prévue pour le cours de psychologie 150. Durant les dix premières minutes de chaque heure, l'étudiant répond à un questionnaire alors que dans les quarante minutes qui suivent, il discute un texte qu'il a résumé, fait une évaluation du travail de ses confrères et son propre travail est ensuite évalué par un étudiant du deuxième ou du troisième cycles qui écoute leur discussion. Pendant une autre séquence de sept semaines, il assiste à des laboratoires d'une heure par jour, quatre jours par semaine. Pendant les dix premières minutes, il répond à un questionnaire. Ensuite, pendant 40 minutes il poursuit une expérience de laboratoire. Chaque semaine, il soumet un rapport dans lequel il fait le point sur cette expérience. Il est de plus soumis à deux examens par semestre. Le tableau VII fait état des activités des étudiants dans cette structure.

Les activités des responsables de l'enseignement figurent sur le tableau VIII.

Ce cours de psychologie 150 coûte $ 7666,66. Le coût par étudiant est $ 6.64, le coût moyen par heure de $ 2.85 et le coût moyen par étudiant par heure d'enseignement de $ o.11. Ceci est en grande partie attribuable aux économies d'échelles, d'une part, et à l'utilisation qui est faite des ressources humaines impliquées d'autre part. On peut voir sur le tableau IX le résumé des coûts pour diverses activités impliquées dans l'enseignement du cours de psychologie 150. On discute ensuite des implications de cette méthode d'enseignement pour l'université en faisant ressortir le fait que les étudiants du deuxième et du troisième cycles paient des frais de scolarité pour les crédits qu'ils reçoivent pour le cours auquel ils ont travaillé alors que le coût de production pour ces crédits est relativement bas comme on vient de le voir. Des méthodes plus traditionnelles coûteraient à l'université $ 9.50 de plus par étudiant.

TABLEAU VII

REPLICATION STRUCTURE - STUDENT ACTIVITY

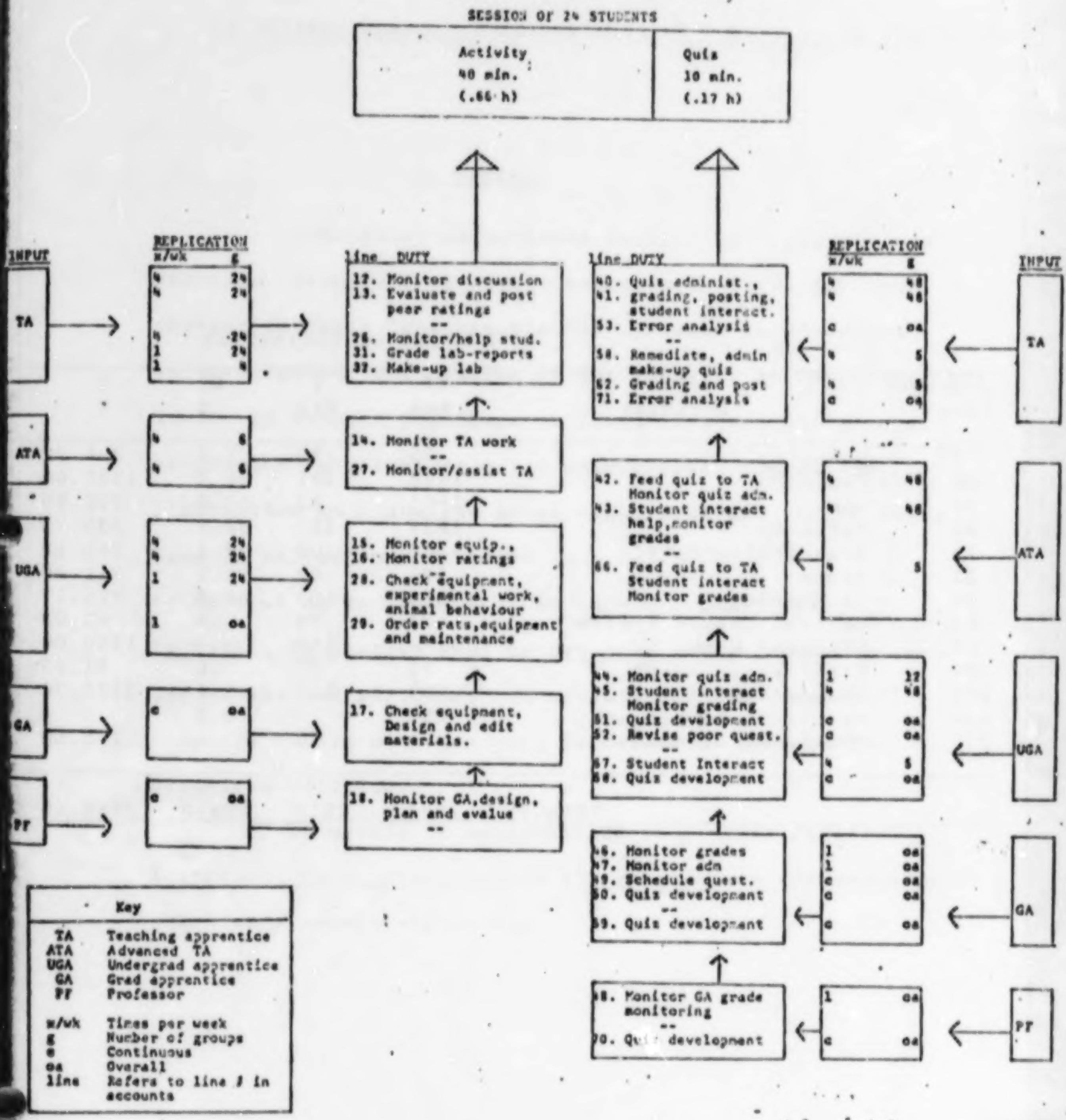

TOTAL ENROLMENT 1152
1st 7 weeks
GROUP "A" 576 SEMINARS
+
GROUP "B" 576 LABORATORY
2nd 7 weeks
GROUP "B" 576 SEMINARS
+
GROUP "A" 576 LABORATORY

TIME				
8	24 in 4's	24 in 4's	24	24
9	24 in 4's	24 in 4's	24	24
10	24 in 4's	24 in 4's	24	24
11	24 in 4's	24 in 4's	24	24
12	24 in 4's	24 in 4's	24	24
13	24 in 4's	24 in 4's	24	24
14	24 in 4's	24 in 4's	24	24
15	24 in 4's	24 in 4's	24	24
16	24 in 4's	24 in 4's	24	24
17	24 in 4's	24 in 4's	24	24
18	24 in 4's	24 in 4's	24	24
19	24 in 4's	24 in 4's	24	24

DAILY MONDAY THROUGH THURSDAY
INCLUSIVE

TABLEAU VIII

REPLICATION STRUCTURE - STAFF INPUT


SESSION OF 24 STUDENTS
Activity
40 min.
(.66 h)
Quiz
10 min.
(.17 h)
INPUT
REPLICATION
x/wk
g
line DUTY
TA
4 24
4 24
4 24
1 24
1 4
12. Monitor discussion
13. Evaluate and post peer ratings
--
26. Monitor/help stud.
31. Grade lab-reports
32. Make-up lab
ATA
4 6
4 6
14. Monitor TA work
--
27. Monitor/assist TA
UGA
4 24
4 24
1 24
1 oa
15. Monitor equip.,
16. Monitor ratings
28. Check equipment, experimental work, animal behaviour
29. Order rats, equipment and maintenance
GA
c oa
17. Check equipment, Design and edit materials.
PF
c oa
18. Monitor GA, design, plan and evalue
--
line DUTY
40. Quiz administ.,
41. grading, posting, student interact.
53. Error analysis
--
58. Remediate, admin make-up quiz
62. Grading and post
71. Error analysis
REPLICATION
x/wk
g
4 48
4 48
c oa
4 5
4 5
c oa
INPUT
TA
42. Feed quiz to TA Monitor quiz adm.
43. Student interact help, monitor grades
--
66. Feed quiz to TA Student interact Monitor grades
4 48
4 48
4 5
ATA
44. Monitor quiz adm.
45. Student interact Monitor grading
51. Quiz development
52. Revise poor quest.
--
57. Student Interact
58. Quiz development
1 12
4 48
c oa
c oa
4 5
c oa
UGA
46. Monitor grades
47. Monitor adm
49. Schedule quest.
50. Quiz development
--
59. Quiz development
1 oa
1 oa
c oa
c oa
c oa
GA
48. Monitor GA grade monitoring
--
70. Quiz development
1 oa
c oa
PF

Key	
TA	Teaching apprentice
ATA	Advanced TA
UGA	Undergrad apprentice
GA	Grad apprentice
PF	Professor
x/wk	Times per week
g	Number of groups
c	Continuous
oa	Overall
line	Refers to line # in accounts

TABLEAU IX

SUMMARY OF ACTIVITIES

Accounts Line	Activity	CT hrs	$ hrs	CT C	$ C	CU
7	Lectures	56	92	1.3	394.72	.3
20	Seminars	1446	291	34.7	1229.40	1.0
34	Labs	1404	87	33.6	222.60	.1
55	Quizzes	1617	227	38.8	535.72	.4
73	Remediation-Requiz	1566	100	37.5	241.18	.8
82	Exams	124	62	2.9	211.86	.1
89	TA Meetings	868	105	20.8	296.17	.2
93	Central Excuse System	21	28	.5	42.00	.0
94	Clerical Work	-	560	-	1260.00	1.0
102	Staff Recruitment	25	45	.6	81.65	.0
115	Evaluations	100	343	2.4	2375.76	2.0
120	Materials Development	125	-	3.0	-	
124	Public Relations	-	70	-	775.60	.0
	TOTALS	7352	2010	176.0	7666.66	6.

CHAPITRE IV

LE SYSTEME COMPTABLE ET SON UTILITE POUR FIN DE DECISIONS.

L'adoption de méthodes analytiques pour fin de décision introduit une façon nouvelle de faire qui peut changer de façon considérable les systèmes de décisions universitaires. Des données et des analyses se rapportant aux inputs et outputs physiques et financiers des différents programmes en marche dans les universités, remplacent l'intuition et l'analyse moins rigoureuse qui ont eu cours dans le milieu universitaire.

Comme tout autre instrument de nature scientifique, le modèle de gestion peut ne pas être neutre, dans le sens que seules les personnes qui connaissent les données, les concepts et les méthodes sont en mesure de prendre des décisions efficaces.

Le modèle de comptabilité peut ainsi devenir un instrument de participation ou d'exclusion aux décisions selon que l'on y aura accès ou non.

Le système comptable pourra servir à différents types de décisions. Des décisions intra-universitaires, inter-universitaires et extra-universitaires.

Cette ventilation est utilisée pour fins analytiques car il y a bien sûr des inter-dépendances entre les décisions prises dans l'un ou l'autre des secteurs.

Dans le domaine des décisions intra-universitaires, nous posons la question à savoir qui a pouvoir de décision sur quelles variables et selon quels critères ? Quelles responsabilités devraient revenir aux étudiants, aux professeurs, ou aux administrateurs, et jusqu'à quel point les décisions devraient être prises seules ou conjointement ?

Nous pensons que l'introduction de nouvelles procédures comptables ne changent pas nécessairement les pouvoirs de décisions des parties impliquées à condition que ceux qui ont contribué aux décisions dans le passé puissent se servir de nouveaux systèmes d'analyse et de renseignements. La distribution de l'influence et du pouvoir parra être cependant affectée puisque toute personne ayant un accès privilégié aux renseignements à partir desquels sont prises les décisions, est en meilleure position et peut plus facilement défendre son argumentation dans le nouveau contexte qui est si fortement axé sur les renseignements.

Pour les décisions inter-universitaires, signalons que les méthodes comptables proposées, une fois généralisées, permettraient tout naturellement des comparaisons des programmes d'enseignement et de recherche et des comparaisons de coûts comme celles que nous avons envisagées dans le chapitre III.

On fait ressortir, par exemple, qu'on s'attend à ce que les coûts soient plus élevés dans un des départements, si ce département dispense ses cours à des groupes plus restreints d'étudiants et si les professeurs y sont mieux payés et ont des heures de contact moins nombreuses que dans d'autres départements.

Le nombre des variables qui jouent dans la détermination des coûts nous amènent à penser, qu'à priori, il est difficile de savoir quelles variables sont les plus importantes dans l'explication des disparités de coûts. Il nous semble que ce n'est que par l'analyse de données plus complètes que l'on pourrait probablement vérifier quelles sont les variables les plus importantes.

Nous pensons que des groupes inter-universitaires, comme la Conférence des Recteurs et des Principaux des Universités du Québec pourraient s'intéresser à la normalisation de certaines activités des universités. La normalisation des coûts moyens par étudiant pour n'importe quel programme peut être atteinte de multiples façons dont certaines seraient inefficaces du point de vue pédagogique ou du point de vue économique. Il apparaît enfin que le modèle comptable proposé permet d'examiner et de comparer ce qui est inter-institutionnellement comparable et ce qu'il est possible de normaliser, en tout, en partie ou pas du tout.

Il se pourrait aussi que si le modèle comptable, était généralisé et appliqué dans toutes les institutions, on pourrait arriver plus rationnellement à la mise au point de programmes dans les institutions.

Dans le domaine des décisions extra-universitaires, signalons que, dans la conjoncture présente, on peut s'attendre à ce que les gouvernements qui financent la plus grosse partie des sommes que dépensent les universités exigent d'elles que leurs demandes de fonds soient bien justifiées.

Ceci peut impliquer la justification d'un programme lui-même, ou des ressources requises et conséquemment de l'utilisation des fonds qui en découlent.

C'est alors et à ce niveau que se pose le problème de l'indépendance des universités par rapport au gouvernement.

Les universités hésiteront peut-être à présenter des demandes de fonds dans le cadre "program-budget" car ces présentations invitent à un examen détaillé des programmes proposés et des coûts qui en résultent. Il semble y avoir un dilemme quant à la façon d'acquérir des fonds de manière à satisfaire à la fois la liberté des universités et le besoin des pouvoirs publics. Pour contourner ce dilemme, il nous semble possible d'utiliser une ou des formules de financement. En examinant la formule de financement utilisée en Ontario, on en arrive à la conclusion que ce qui est un avantage au point de vue des universités est un désavantage du point de vue du secteur public. En effet, la formule ontarienne exempte les universités de fournir un compte-rendu très détaillé de l'utilisation qu'elles font des sommes qui sont à leur disposition.

La contre-partie de ceci c'est de rendre plus difficile la compréhension du fonctionnement de l'université pour le public. Or, il apparaît que, de plus en plus les dépenses publiques sont substituables entre elles. Il nous semble donc que, de plus en plus, le citoyen devra être à même d'établir des priorités dans ces dépenses : la budgétisation par programme facilitera cette tâche. Dans cette optique, le problème des subsides aux universités en est un d'optimalité et d'équité. Il devrait être examiné à la lumière de l'analyse"paretienne". Si les subsides rencontrent les demandes fixées de façon autonome par chaque université, le critère"paretien"de bien-être, selon lequel l'individu est le seul juge de son bien-être, est respecté. Appliqué à l'université, le critère"paretien"pourrait se formuler ainsi : l'institution universitaire est le seul juge de son niveau de satisfaction. On peut dire que ce critère de satisfaction n'est pas anti-social, dans la mesure où une institution universitaire, aujourd'hui, doit nécessairement insérer les mêmes objectifs sociaux que ceux de la collectivité dans sa fonction de préférence.

Cependant le danger de l'application d'une formule de financement du type ontarien, est que certaines institutions abandonnent leurs objectifs à long terme de formation et de recherche pour profiter au maximum des faiblesses de la formule de financement. On peut ainsi favoriser des gaspillages importants.

En effet, les besoins des institutions diffèrent et ne peuvent être résumés dans une formule de financement générale. Les facteurs qui expliquent la divergence des besoins des universités sont, d'une part leurs développements, et d'autre part, la situation particulière de chaque université.

Le problème du développement divergent est celui qui explique que les coûts par étudiant peuvent différer entre les institutions à cause de leur histoire et de leur développement antérieur. A cet égard, toute tentative d'établir une norme de financement générale peut être inefficace dans le sens qu'elle peut engendrer le sur-financement de certaines activités et le sous-financement de certaines autres.

Cette situation particulière se manifeste quand une de ces dépenses ne peut rentrer dans la norme générale, soit à cause du fait qu'elle est particulière à une ou à quelques institutions soit à cause du fait que par nature la dépense est trop complexe et qu'il est impossible de l'incorporer dans une formule de financement.

Un déséquilibre entre l'offre et la demande de fonds se produit lorsque les normes contribuent à surfinancer certaines institutions et sous-financer certaines autres. Une telle situation n'est pas seulement inéquitable, elle est aussi irrationnelle, en ce sens qu'elle crée des dépenses inutiles dans certains endroits et ne permet pas de rencontrer certaines dépenses nécessaires dans d'autres. Elle est inéquitable parce qu'elle produit des niveaux de satisfaction différents. Ces différences pourraient être corrigées en opérant une redistribution entre les universités.

On a souvent vu une valeur moyenne des inefficacités du passé augmentée pour tenir compte de l'inflation des coûts, et devenir la norme générale d'allocation financière; situation guère "efficace".

Par efficacité technique, on entend des procédures qui permettent l'obtention d'objectifs par la méthode la moins coûteuse. Bien qu'il n'y ait aucune raison de croire que la façon de faire qui a été adoptée dans le passé soit la plus efficace, il n'en demeure pas moins que, souvent, les critères de financement sont le reflet de ce que les universités ont fait dans le passé. Les formules de financement sont généralement établies en faisant des analyses historiques des coûts des universités. Une telle méthode perpétue les structures existantes et passées, n'encourage en rien le changement dans les façons de faire des universités, sauf lorsque, par accident, des déséquilibres se créent entre l'offre et la demande de fonds.

Ainsi, le financement par formule ne semble pas un moyen infaillible de repartir de façon équitable et efficace les subsides entre les universités.

Au terme de ce chapitre, nous constatons que les universités ne sont pas prêtes à adopter un mode de financement qui reposerait sur le "program budgeting" par peur de voir diminuer leur indépendance par rapport au gouvernement et que, d'autre part, le financement par formule ne permet pas forcement une efficacité et une équité suffisante. Une façon de résoudre ce dilemme serait peut-être que les organismes qui donnent les subsides ne se soucient en aucune façon de la répartition de ces subsides entre les institutions. Ces dernières s'entendraient entre elles afin de déterminer et de créer les mécanismes distributifs, tels que le PPBS ou peut-être une approche par formule. Une telle procédure devrait s'accompagner de la part des universités d'une étude poussée de coûts. Cette étude serait donnée au gouvernement afin de lui permettre de fixer les sommes totales à mettre à la disposition des universités en fonction des contraintes générales de la société.

Ainsi le gouvernement et tous les milieux extra-universitaires seraient tenus au courant de l'activité des universités, et le milieu universitaire conserverait toute liberté de gérer les fonds mis à sa disposition et d'élaborer une planification de ses programmes et de ses activités.

Enfin, bien que des personnes du milieu universitaire et extra-universitaire soient intéressées à la question du contenu des programmes, il faut tout de même maintenir la distinction entre la collaboration et la coercition. Selon la procédure envisagée, des personnes du milieu extra-universitaire ne seraient pas directement impliquées dans la planification des programmes et dans l'utilisation des structures comptables proposées dans cette étude. Les sources extérieures à l'université s'en remettraient donc aux universités en espérant que celles-ci soient les plus efficaces possibles dans leurs décisions de nature financières et pédagogiques.

LES ANNEXES

L'annexe 1 est une présentation de la méthode pédagogique proposée par le professeur Kingsburg pour enseigner les mathématiques dans son "Mathematics learning Center" à McGill.

L'annexe II est une étude technique qui présente la solution mathématique des contraintes de coûts et qui fait une analyse des possibilités, c'est-à-dire qui montre comment devrait varier telle ou telle variable pour que le résultat change de tant quand tout le reste reste constant.

L'annexe III fait ressortir les implications de l'application dans le temps de la procédure comptable proposée. Nous insistons aussi sur l'importance de mettre au point un plan de développement académique des universités, et nous donnons une liste des variables à planifier.

L'annexe IV contient tous les tableaux impliqués pour l'étude d'un département. Le jeu complet de ces tableaux, ainsi qu'un jeu de tableaux portant sur les activités des professeurs, non identifiés par département, sont disponibles au secrétariat de la Conférence des Recteurs et des Principaux des Universités du Québec.

L'annexe V comporte quelques suggestions quant aux projets qui devraient découler de la présente étude.

AUTRES ETUDES ET DOCUMENTS DE TRAVAIL DE LA CONFERENCE DES RECTEURS ET DES PRINCIPAUX DES UNIVERSITES DU QUEBEC

1.	Rapport annuel de la Conférence des recteurs et des principaux des Universités du Québec. Décembre 1969.	
2.	"Rapport des communications présentées à la session d'études du personnel des services aux étudiants des Universités du Québec", à l'Université Bishop's, mai 1968. Comité interuniversitaire de la vie étudiante (CIVE), 54 pages	$ 3.50
3.	"Rapport des communications présentées à la session d'études du personnel des services aux étudiants des Universités du Québec", à l'Université de Sherbrooke, mai 1970. Comité interuniversitaire de la vie étudiante (CIVE), 93 pages.....	$ 4.50
4.	"Etudes et Propositions en vue de la mise en place d'une échelle normée de traitement pour les professeurs des Universités du Québec", J. Bordeleau, A.P. Contandriopoulos, N. Hung, 30 janvier 1970, 213 pages	$ 7.50
5.	"The Political Economy of Resource Distribution in Quebec Universities", M.D. Segal, octobre 1970, 430 pages..................................	$ 14.00
6.	"Prévision des besoins en main-d'oeuvre hautement qualifiée et planification de l'éducation", André-Pierre Contandriopoulos, mai 1971, 246 pages	$ 5.00

Exhibit 1

Sample - Cou

	1	2	3	4	5	6	7	8	9	10	11	12	
FIU & I	a	b	d	y	h	Fa	e	e'	e^J	g	Th	Ta	
Course "x" Activity "y"	26	.5	1	2	2	26	315	315	-	1	2	26	1
	Activity lasts 26 weeks per. year	The student attends every 2 weeks	Each lesson lasts 1 hour	Each student attends 2 lessons per "b"	(d.y) Or the number of hours per "b" that each student is at lessons	(a.b.h.) The number of hours per annum the student attends the activity	Number of students enrolled	Participation per session all 315 sit at the same time	Ratio Student/ Demonstrator in labs.	(e/s) The number of groups	(g/h) Number of hours teaching needed per "b"	a(Th.b.) or (Fa.g) Number of hours teaching needed per year	Ide profe

Note: Col.2, "b":

b = 1, occurrence = 1 week
.5 = 1/2 weeks
.67 = 1/10 days
.25 = 1/month

Note: Col.13:

1 = Full prof.
2 = Associate prof.
3 = Assistant prof.
4 = Lecturer

L = Lecture
A = Laboratory
S = Tutorial
E = Correction
N = Administration; preparation

Graphique I

Échantillon - Comptabili

	1	2	3	4	5	6	7	8	9	10	11	12	13
FIU & I	a	b	d	y	h	Fa	e	e'	e^J	g	Th	Ta	1
Cours "x" Activité "y"	26	.5	1	2	2	26	315	315	-	1	2	26	1234
	L'activité dure 26 semaines par année	L'étudiant participe toutes les 2 semaines	Chaque leçon dure 1 heure	Chaque étudiant assiste à 2 leçons par "b"	(d.y.) ou le nombre d'heures par "b" que chaque étudiant est aux leçons	(a.b.h.) Le nombre d'heures par année que l'étudiant assiste à l'activité	Nombre effectif d'étudiants inscrits	La participation par séance Tous les 315 assistent à la fois	Rapport étudiants (démonstrateurs) pour laboratoire	(e/s) Le nombre de groupes	(g.h.) Le nombre d'heures d'enseignement requis par "b"	a.(Th.b.) ou (Fa.g) Nombre d'heures d'enseignement requis par année	sigl de professe

Note: Col.2, "b":

b = 1 conséquemment = 1/sem.
.5 = 1/2 sem.
.67 = 1/10 jours
.25 = 1 mois

Note: Col.13:

1 = professeur titulaire
2 = professeur agrégé
3 = professeur adjoint
4 = chargé d'enseignement

L = Conférence
A = Laboratoire
S = Séminaire
E = Correction
N - Administration; Préparation

DEMO
TUTR
CORR
PTTH
PDP

EXHIBIT 3

Sample - Course Accounting Framework

	10	11	12	13	14	15	16	17	18	19	20	21	22
	g	Th	Ta	I	R	a	SA	Ft	C	CU	CH	A	T.a.
	1	2	26	1234	1	104	10,000	.250	2500	7.94	96.15	.31	8190
atio udent/ structor abs.	(n/s) The number of groups	(g/h) Number of hours teaching needed per "h"	n(Th.h.) or (Ta.g) Number of hours teaching needed per year	Identity of professor	Professor rank	His total load in contact hours per year	Annual salary	(Ta/a) He spends .25 of his total load on this activity	(Ft.SA) Its costs is $2,500.	(C/n) Unit cost per student in $	(C/Ta) Cost per hour of teaching	(CH/n) Cost per hour per student sitting in this activity	Weighting factor

L = Lecture
A = Laboratory
S = Tutorial
R = Correction
M = Administration; preparation

DEMO = Demonstrator
TUTR = Tutor
CORR = Corrector
PTTM = Part-time
PDF = Post-doctoral

GRAPHIQUE 3

Echantillon - Comptabilité des cours

	10	11	12	13	14	15	16	17	18	19	20	21	22
	g	Th	Ta	I	R	a	SA	Ft	C	CU	CH	A	T.a
	1	2	26	1234	1	104	10,000	.250	2500	7.94	96.15	.31	8190
port nts ctra- ules	(n/s) Le nombre de groupes	(g.h.) Le nombre d'heures d'enseignement requis par "g"	a.(Th.h.) ou (Ta.g) Nombre d'heures d'enseignement requis par année	sigle du professeur	rang du professeur	sa charge totale d'heures de contact par année	salaire annuel	(Ta/a) Il passe .25 de sa charge totale sur cette activité	(Ft.SA) Le coût en est de $ 2,500.	(C/n) Coût unitaire par étudiants en $	(C/Ta) Coût par heure d'enseignement	(CH/n) Coût par heure par étudiant en cette activité	Facteur de pondération

L = Conférence
A = Laboratoire
S = Séminaire
R = Correction
M = Administration; Préparation

DEMO = Démonstrateur
TUTR = Tuteur
CORR = Correcteur
PTTM = Temps partiel
PDF = Post-Doctoral